



*Shri Shamrao Patil (Yadavkar) Educational and Charitable Trust's*  
**Sharad Institute of Technology College of Engineering**  
**An Autonomous Institute**  
Yadav (Ichalkaranji), Dist: Kolhapur, Maharashtra-416121

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# **Teaching and Evaluation Scheme**

## **B. Tech in Electrical Engineering**



*Shri Shamrao Patil (Yadavkar) Educational and Charitable Trust's*  
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Yadav (Ichalkaranji), Dist: Kolhapur, Maharashtra-416121

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## **Abbreviations**

**L:** Lecture

**T:** Tutorial

**P:** Practical

**CA1:** Continuous Assessment 1

**CA2:** Continuous Assessment 2

**MSE:** Mid Semester Exam

**ESE:** End Semester Exam

**BSC** -Basic Science Courses

**ESC:** Engineering Science Courses

**AEC:** Ability Enhancement Courses

**IKS:** Indian Knowledge System

**VSEC:** Vocational and Skill Enhancement Course

**CEP:** Community Engagement Project

**PCC:** Program Core Course

**PEC:** Program Elective Course

**HSSM:** Humanities, Social Sciences, and Management Course

**CC:** Co-Curricular Courses



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## **Teaching and Evaluation Scheme for FY B. Tech**

**Department of Electrical Engineering**

**Semester (s): I and II**





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**Department:** Electrical Engineering

**Rev:** Course Structure/00/2023-24

**Class:** F.Y. B.Tech

**Semester:** I

Course Code	Type of Course	Name of the course	Teaching Scheme			Evaluation scheme				Credits
			L	T	P	CA1	CA2	MSE	ESE	
23EE1101	BSC	Applied Mathematics-I	3	1	0	10	10	30	50	4
23EE1102	BSC	Applied Chemistry	2	0	0	10	10	30	50	2
23EE1103	IKS	Indian Knowledge System	2	0	0	10	10	30	50	2
23EE1104	ESC	Basic Electronics Engineering	1	0	0	5	5	15	25	1
23EE1105	ESC	Basic Civil Engineering	1	0	0	5	5	15	25	1
23EE1106	ESC	Engineering drawing	1	0	0	5	5	15	25	1
23EE1107	ESC	Basic Electrical Engineering	1	0	0	5	5	15	25	1
23EE1108	BSC	Applied Chemistry Laboratory	0	0	2	25	25	-	-	1
23EE1109	ESC	Basic Electronics Engineering Laboratory	0	0	2	25	25	-	-	1
23EE1110	ESC	Basic Civil Engineering Laboratory	0	0	2	25	25	-	-	1
23EE1111	ESC	Engineering drawing Laboratory	0	0	2	25	25	-	-	1
23EE1112	ESC	Basic Electrical Engineering Laboratory	0	0	2	25	25	-	-	1
23EE1113	VSEC	Workshop Practices	0	0	2	25	25	-	-	1
23EE1114	VSEC	Electrical Workshop	0	0	2	25	25	-	-	1
23EE1115	CC	Yoga/Sports Practicals/Mini Project	0	0	4	25	25	-	-	2
<b>Total</b>			<b>11</b>	<b>1</b>	<b>18</b>	<b>250</b>	<b>250</b>	<b>150</b>	<b>250</b>	<b>21</b>



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**Department:** Electrical Engineering

**Rev:** Course Structure/00/2023-24

**Class:** F.Y. B.Tech

**Semester:** II

Course Code	Type of Course	Name of the course	Teaching Scheme			Evaluation Scheme				Credits
			L	T	P	CA1	CA2	MSE	ESE	
23EE1201	BSC	Applied Mathematics- II	3	1	0	10	10	30	50	4
23EE1202	BSC	Applied Physics	2	0	0	10	10	30	50	2
23EE1203	AEC	Communication Skills	1	0	0	5	5	15	25	1
23EE1204	ESC	Fundamentals of Mechanical Engineering	1	0	0	5	5	15	25	1
23EE1205	ESC	Engineering Mechanics	2	0	0	10	10	30	50	2
23EE1206	PCC	Fundamentals of Electrical Circuits	2	0	0	10	10	30	50	2
23EE1207	VSEC	Problem Solving using C Programming	2	0	0	10	10	30	50	2
23EE1208	BSC	Applied Physics Laboratory	0	0	2	25	25	-	-	1
23EE1209	AEC	Communication Skills Laboratory	0	0	2	25	25	-	-	1
23EE1210	ESC	Fundamentals of Mechanical Engineering Laboratory	0	0	2	25	25	-	-	1
23EE1211	ESC	Engineering Mechanics Laboratory	0	0	2	25	25	-	-	1
23EE1212	VSEC	Problem Solving using C Programming Laboratory	0	0	2	15	15	-	20	1
23EE1213	CC	Yoga/Sports Practicals/Mini Project	-	-	4	25	25	-	-	2
<b>Total</b>			<b>13</b>	<b>1</b>	<b>14</b>	<b>200</b>	<b>200</b>	<b>180</b>	<b>320</b>	<b>21</b>



### Applied Mathematics-I

23EE1101	BSC	Applied Mathematics-I	3-1-0	4 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 Hrs/week Tutorial: 1Hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks

**Pre-Requisites:** HSC Mathematics

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Apply the concept basic laws of derivatives in partial differentiation to solve first and higher order derivative.
CO2	Apply the concept of partial derivative, to find Jacobin, series expansion and maxima and minima of functions of two variables.
CO3	Use of characteristics of complex numbers in problems pertaining to Electric Circuit, Mechanical System etc.
CO4	Apply the concept of linear transformation to solve the linear equations,
CO5	Apply the Eigen values and Eigen Vectors to use Cayley-Hamilton theorem to find inverse of the matrix.
CO6	Apply the concept of linear algebra to solve numerically linear simultaneous equations.

**Course Contents:**

<b>Unit 1: Partial differentiation</b> Partial derivatives of first and higher orders, Homogeneous functions-Euler's theorem, Total derivative, Change of variables, Differentiation of implicit function.	<b>[8]</b>
<b>Unit 2: Application of partial derivative</b> Jacobians – properties, Taylor's and Maclaurin's theorem for functions of one and two variables, Errors and approximations, Maxima and minima of functions of two variables.	<b>[6]</b>
<b>Unit 3: Complex numbers</b> De-Moivre's theorem (without proof), Roots of complex numbers by using De-Moivre's theorem, Expansion of $\sin n\theta$ and $\cos n\theta$ in powers of $\sin\theta$ and $\cos\theta$ , Circular functions of complex variable-definition, Hyperbolic functions, Relations between circular and hyperbolic functions, Real and imaginary parts of circular and hyperbolic functions, Logarithm of complex quantities.	<b>[8]</b>
<b>Unit 4: Matrices and Solution of simultaneous linear equations</b> Elementary row and column transformations on a matrix Rank of a matrix-normal form and Echelon form, Consistency and solutions of systems of linear equations using elementary transformations.	<b>[8]</b>
<b>Unit 5: Eigen values and Eigen vectors</b> Linear dependence and independence of vectors, Eigen values and Eigen vectors,	<b>[6]</b>



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Properties of Eigen values and Eigen vectors, Cayley Hamilton's theorem (without proof) and its applications.	
<b>Unit 6: Numerical solution of simultaneous linear equations</b> Gauss elimination method, Gauss- Jordan method, Jacobi's iteration method, Gauss-Seidal iteration method, Determination of Eigen values by iteration.	<b>[6]</b>
<b>Textbooks:</b> <ol style="list-style-type: none"><li>1. P. N. Wartikar and J. N. Wartikar: A Text Book of Applied Mathematics. (Vol I and II), Pune Vidyarthi Griha Prakashan, Pune</li><li>2. N. P. Bali: A Text Book of Engineering Mathematics, Laxmi Publications, New Delhi.</li><li>3. Peter O' Neil: A Text Book of Engineering Mathematics, Thomson Asia Pvt. Ltd., Singapore.</li></ol>	
<b>Reference Books:</b> <ol style="list-style-type: none"><li>1. B. S. Grewal: Higher Engineering Mathematics, Khanna Publishers.</li><li>2. Erwin Kreyszig: Advanced Engineering Mathematics, John Wiley and Sons.</li><li>3. B. V. Ramana: Higher Engineering Mathematics, McGraw-Hill Publications, New Delhi</li><li>4. C. R. Wylie and L. C. Barrett: advanced Engineering Mathematics, McGraw Hill Publishing Company Ltd.</li></ol>	



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### Applied Chemistry

23EE1102	BSC	Applied Chemistry	2-0-0	2 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 2 Hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks

**Pre-Requisites:** Pre-Requisites: 11<sup>th</sup> and 12<sup>th</sup> Science

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Explain and determine various characteristics of water to develop water treatment methods to solve environmental problems.
CO2	Illustrate and demonstrate different rapid and reliable analytical instrumental methods for chemical analysis.
CO3	Demonstrate the knowledge of advanced engineering materials for various engineering applications.
CO4	Analyze the quality of fuel and select proper fuel for industrial purpose.
CO5	Outline the knowledge of corrosion for prevention of materials from corrosion.
CO6	Make use of metallic materials approach in the industrial point of view.

#### Course Contents:

<b>Unit 1: Water Treatment</b> Introduction, Impurities in natural water, Hardness of water-units, Types and numerical, BOD, COD definition, Ill effects of hard water in steam generation in boilers, Water purification-membrane technology-Reverse osmosis process, Electrodialysis, Ultra filtration.	[5]
<b>Unit 2: Instrumental methods of chemical analysis</b> Introduction, Advantages and disadvantages of instrumental methods, <b>A) Spectrometry:</b> Introduction, Laws of spectrometry (Lamberts and Beer-Lamberts law), <b>B) Chromatography:</b> Introduction, types, Gas-liquid chromatography (GLC), Basic principle, Instrumentation and applications.	[5]
<b>Unit 3: Advanced Materials</b> <b>A) Polymers:</b> Introduction, Plastics, Thermo softening and thermosetting plastic, industrially important plastics like phenol formaldehyde and urea formaldehyde biodegradable polymers Poly (hydroxybutyrate-hydroxyvalanate) and applications. <b>B) Nanomaterial's:</b> Introduction, Classification of nanomaterial's based on dimensions, Structure, Properties and applications of Graphene.	[5]
<b>Unit 4: Fuels</b> Introduction, Classification, Calorific value, Types of calorific value (higher and lower), Characteristics of good fuels, Comparison between solid, Liquid and gaseous fuels, Gaseous fuel: composition properties and applications of CNG, Determination of calorific value of fuel by bomb calorimeter and by Boy's calorimeter, Numerical on bomb and Boy's calorimeter, Fuel cells: Introduction, Classification, advantages,	[5]



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Limitations and applications.	
<b>Unit 5: Corrosion</b> Introduction, causes, Atmospheric corrosion (oxidation corrosion), Electrochemical corrosion (hydrogen evolution and oxygen absorption mechanism), Factors affecting rate of corrosion, Prevention of corrosion by proper design and material selection, Protective coatings hot-dipping (galvanizing and tinning, Metal Spraying and electroplating).	[5]
<b>Unit 6: Metallic materials and composite materials</b> <b>A) Metallic materials:</b> Introduction, Alloy definition and classification, Purposes of making alloys, <b>Ferrous alloys:</b> Plain carbon steels (mild, medium and high), Stainless steels, <b>Nonferrous alloys:</b> Copper alloy (Brass), Nickel alloy (Nichrome) <b>B) Composite materials:</b> Introduction, Composition, Properties and uses of fiber reinforced plastics (FRP) and glass reinforced plastic (GRP).	[5]
<b>Textbooks:</b> 1. Engineering Chemistry by Jain and Jain, Dhanpat Rai Publishing Company Ltd., New Delhi. 2. A Textbook of Engineering Chemistry by S. S. Dara and S. S. Umare, S. Chand and Company Ltd., New Delhi. 3. A Textbook of Engineering Chemistry by C. P. Murthy, C. V. Agarwal and A. Naidu, BS Publications, Hyderabad. 4. Engineering Chemistry by Dr. A. K. Pahari and Dr. B. S. Chauhan, Laxmi Publications (P) Ltd, New Delhi. 5. A text Book of Engineering Chemistry by Shashi Chawla, Dhanpat Rai and Co. (Pvt.) Ltd, Delhi. 6. Engineering Chemistry by Renu Bapna and Renu Gupta, MacMillan Publishers (India) Ltd, Delhi.	
<b>Reference Books:</b> 1. D. A. Skoog, D. M. West, Fundamentals of Analytical Chemistry, Cengage Learning. 2. A. I. Vogel, Quantitative Chemical Analysis, Longmann Publication. 3. Chatwal and Anand, Instrumental Methods of Chemical Analysis, Himalaya Publishing House, New Delhi. 4. S. K. Kulkarni, Nanotechnology: Principals and Practices, Capital Publishing Company. 5. B. K. Sharma, Environment Chemistry, Goel Publication, Meerut. 6. K. J. Sundars, Organic Polymer Chemistry, Springer Publication. 7. B. K. Sharma, Instrumental Methods of Chemical Analysis, Goel Publication, Meerut.	



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**Indian Knowledge System**

23EE1103	IKS	Indian Knowledge System	2-0-0	2 Credits
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Teaching Scheme	Evaluation Scheme
Lectures: 2 Hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks

**Pre-Requisites:** Basic knowledge Indian culture and heritage

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Remember Indian culture and heritage.
CO2	Understand Indian art.
CO3	Understand Indian architecture.
CO4	Understand Indian painting and tradition.
CO5	Understand the performing arts in India.
CO6	Understand science and technology in India.

**Course Contents:**

<b>Unit 1: Indian culture: An introduction</b> Concept of culture, Culture and heritage, General characteristics of culture, Importance of culture in human life, Characteristics of Indian culture, Significance of geography on Indian culture.	[5]
<b>Unit 2: Indian art</b> Indian sculpture: Gandhara school and mathura school of art.	[5]
<b>Unit 3: Indian architecture</b> Meaning, Form and context, Perception of India's architectural tradition: Historiography, Cave architecture, medieval architecture of India, Colonial architecture.	[5]
<b>Unit 4: Indian painting tradition</b> Ancient Indian painting tradition: Pre-classical period, Classical period and post-classical period, Indian handicraft.	[5]
<b>Unit 5: Performing arts</b> Concept of performing arts, Divisions of Indian classical music-Hindustani classical music, carnatic music, Modern Indian music, Musicians, Folk music, Dances of India, Indian cinema.	[5]
<b>Unit 6: Science and technology</b> <b>Science:</b> Kanad, Varahamihira, Nagarjuna, Medical science in ancient India (Ayurveda and Yoga): Susruta, Charak, Yoga and patanjali, <b>Mathematics and astronomy:</b> Baudhayan, Aryabhata, Brahmgupta, Bhaskaracharya, Mahaviracharya.	[5]
<b>Text and Reference Books:</b> 1. Pride of India- A Glimpse of India's Scientific Heritage edited by Pradeep Kohle et al. Samskrit Bharati (2006).	



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2. India's Glorious Scientific Tradition by Suresh Soni, Ocean Books Pvt. Ltd. (2010).
3. Indian Culture and Heritage. BB Satpathy. Culture 2 (2015) 25.
4. A.L. Basham, Studies in Indian History and Culture. Sambodhi Publications Pvt. Ltd., Calcutta, 1964.
5. Basham, A.L., The Wonder That Was India. Sidgwick and Jackson, London, 1954.



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### Basic Electronics Engineering

23EE1104	ESC	Basic Electronics Engineering	1-0-0	1 Credit
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Teaching Scheme	Evaluation Scheme
Lecture: 1 Hr/week	CA1: 5 Marks CA2: 5 Marks Mid Semester Exam: 15 Marks End Semester Exam: 25 Marks

**Pre-Requisites:** Basic concepts of Physics.

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Demonstrate the function of different electronic instruments and diode applications.
CO2	Illustrate the different parameters of transistor (BJT).
CO3	Compare the applications of operational amplifiers.
CO4	Classify logic gates and Boolean algebra laws, various electronic appliances.

**Course Contents:**

<p><b>Unit 1: Basics of electronics and diode applications</b>            Evolution of electronics, Introduction of active and passive components-symbols and units, P-N junction Diode- construction and working, VI characteristics of diode, Diode applications: Half wave and full wave rectifier (Centre tapped and bridge) circuits and operation, Zener diode- VI characteristics, Zener diode as voltage regulator.</p>	[4]
<p><b>Unit 2: Bipolar junction transistor (BJT)</b>            Transistor construction and working principle, DC load line, biasing circuits- fixed bias, collector to base bias, voltage divider bias; Transistor configurations CB, CC and CE, Applications of transistor as an amplifier and as a switch.</p>	[4]
<p><b>Unit 3: Introduction to operational amplifier</b>            OPAMP- Definition, Block diagram of OPAMP, Pin diagram of <math>\mu A741</math>, Ideal characteristics, OPAMP applications- Inverting amplifier, Non- inverting amplifier, Voltage follower and comparator, Filters-definition, Types of filters, Working of passive and active filters (working).</p>	[4]
<p><b>Unit 4: Digital electronics</b>            Introduction to number system- Decimal, Binary, Octal, Hexadecimal; Boolean algebra and reduction techniques, Basic logic gates, universal logic gates, Half Adder, Full Adder, Half and full subtractor.</p>	[4]
<p><b>Textbooks:</b></p> <ol style="list-style-type: none"> <li>1. Electronics Fundamentals and Applications, D. Chattopadhyay, P. C. Rakshit, New Age International.</li> <li>2. Linear Integrated Circuits by Ramakant A. Gayakwad, PHI Learning Pvt. Ltd.</li> <li>3. Digital Circuits, Anandkumar.</li> </ol>	
<p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>1. Sedra and Smith, Microelectronics Engineering.</li> </ol>	



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2. John D Ryder. Electronic Fundamentals and applications, PHI.
3. J.B.Gupta, Basic Electronics.
4. Malvino: Electronic Principle.
5. Schilling and Belove: Electronics Circuits.
6. Millman and Halkins Integrated Electronics, Tata McGraw Hill.
7. Bolestead and Nashelsky Electronic Devices and Circuits Theory, PHI,2001.



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**Basic Civil Engineering**

23EE1105	ESC	Basic Civil Engineering	1-0-0	1 Credit
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Teaching Scheme	Evaluation Scheme
Lecture: 1 Hr/week	CA1: 5 Marks CA2: 5 Marks Mid Semester Exam: 15 Marks End Semester Exam: 25 Marks

**Pre-Requisites:** Principles of trigonometry and basic chemistry.

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Classify branches of civil engineering and construction material.
CO2	Identify the components of buildings and structures of building.
CO3	Explain building planning and construction activities.
CO4	Explain concepts of basic surveying and advanced instruments.

**Course Contents:**

<b>Unit 1: Introduction to civil engineering</b> Role of civil engineering in various engineering fields like Mechanical, Electrical, Chemical, Instrumentation, Electronics and Telecommunication etc. Role of civil engineers in various construction activities, Basic construction material- Bricks, Timber, Stone, Aggregate, Sand, Cement, Steel, Bitumen, Glass, Concrete, Mortar.	[3]
<b>Unit 2: Building components</b> Definition of Building, Types of building as per NBC, Basics components of Building -Substructure and Super structure and its function, Types of foundation.	[3]
<b>Unit 3: Building planning and constructions</b> Introduction, Principles of planning, Building bye laws, Introduction of construction activities plastering, pointing and painting.	[3]
<b>Unit:4 Surveying</b> Introduction- Importance, Objectives, Principles of surveying, Linear measurements, Prismatic compass, Types of bearings, Calculation of bearing and angle, Introduction to advance surveying instruments- DGPS, GIS, GPS, Total Station.	[3]
<b>Textbooks:</b> 1. "Basic Civil Engineering" by G.K. Hiraskar. 2. "Basic concepts of civil engineering" by Sunder Narayan.	
<b>Reference Books:</b> 1. Basics of Civil Engineering by S S Bhavikatti. 2. Basic Civil Engineering by Ramamrutham S. 3. Basic Civil Engineering by M.S. Palanichamy. 4. Basic Civil and Mechanical Engineering by K Mysamy and S Shanmuga. 5. Basic Civil Engineering by Rakesh Ranjan Beohar.	



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### Engineering Drawing

23EE1106	ESC	Engineering Drawing	1-0-0	1 Credit
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Teaching Scheme	Evaluation Scheme
Lecture: 1 Hr/week	CA1: 5 Marks CA2: 5 Marks Mid Semester Exam: 15 Marks End Semester Exam: 25 Marks

**Pre-Requisites:** Geometry and Mensuration

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Interpret projection points, lines and planes with reference to principal planes.
CO2	Interpret development of lateral surfaces of the various kinds of solids.
CO3	Interpret the orthographic views of an object.
CO4	Interpret the isometric views of an object.

**Course Contents:**

<b>Unit 1: Projection of points and lines and plane (1<sup>st</sup> Angle Projection only)</b> Introduction to drawing instruments and their uses, Layout of drawing sheets, Lettering, Different types of lines used in drawing practice, Dimensioning system as per BIS conventions (Theoretical treatment only) a) Orthographic projection system, First and Third angle projection methods, Projection of points on regular reference planes (HRP, FRP, PRP) b) Projection of lines—Horizontal, Frontal and oblique lines; Rotation method to find front view and top view. c) Projection of planes (regular polygons and circle) inclined to one reference plane.	<b>[3]</b>
<b>Unit 2: Development of surfaces</b> Development of plane and curved lateral surfaces: Prisms, Pyramids, Cylinders and cones (cutting planes specified).	<b>[3]</b>
<b>Unit 3: Orthographic projections</b> Lines used, Selection of views, spacing of views, dimensioning and conversion of pictorial view into orthographic views.	<b>[3]</b>
<b>Unit 4: Isometric projections</b> Introduction to isometric, Isometric scale, Isometric projections and Isometric views/drawings, Circles in isometric view, Isometric views of simple solids and objects.	<b>[3]</b>
<b>Textbooks:</b> 1. R.K. Dhawan, "A textbook of Engineering Drawing", S. Chand and Co.	
<b>Reference Books:</b> 1. N.D. Bhatt, "Engineering Drawing", Charotar Publication House, Bombay. 2. N.D. Bhatt, "Machine Drawing", Charotar Publication House, Bombay. 3. K. Venugopal, "Engineering Drawing and Graphics", New Age Publication. 4. N.B. Shaha and B.C. Rana, "Engineering Drawing", Pearson Education.	



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### Basic Electrical Engineering

23EE1107	ESC	Basic Electrical Engineering	1-0-0	1 Credit
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Teaching Scheme	Evaluation Scheme
Lecture:1 Hr/week	CA1: 5 marks CA2:5 Marks Mid Semester Examination: 15 Marks End Semester Examination: 25 Marks

**Pre-Requisites:** Basic concepts of Physics.

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Explain electrical quantities and laws.
CO2	Explain magnetic quantities, laws and induction principle.
CO3	Explain fundamentals of ac circuit.
CO4	Explain operation principles of electrical machines.

**Course Contents:**

<b>Unit 1: Elementary concepts</b> Electric current, electric potential, EMF, Resistance, power, energy, ohm's law, series and parallel circuits, KVL, KCL (simple numerical)	<b>[3]</b>
<b>Unit 2: Electromagnetic induction</b> Definition of magnetic quantities: Magnetic circuit, leakage flux, fringing effect, Comparison between magnetic and electric circuit, Faraday's law of electromagnetic induction, Lenz's law, laws of electromagnetic forces, principle of self and mutual induction.	<b>[3]</b>
<b>Unit 3: Fundamentals of AC circuits</b> Generation of voltage, Phase, average value, RMS, Power factor, Form factor, power-active, reactive and apparent peak factor, phasor diagram. (Simple numerical)	<b>[3]</b>
<b>Unit4: Basics of electrical machines</b> Concepts of machine, Introduction, DC Motor –operation principle of DC Motor, Classification and industrial applications, <b>Transformer</b> - operating principle of single phase transformer and industrial applications, <b>AC Machine</b> - operating principle of single phase induction motor and industrial applications	<b>[3]</b>



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**Textbooks:**

1. "Basic Electrical Engineering" by Nagrath, I and Kothari.
2. "Basic Electrical Engineering" by Mittle, V and Arvind Mittle.
3. "Basic Electrical Engineering" by C L Wadhwa.

**Reference Books**

1. "Basic Electrical Engineering" by T K Nagsarkar and M S Sukhija.
2. "Abc of Electrical Engineering" by Theraja B L and Theraja A K.
3. "Basic Electrical and Electronics Engineering" by S K Bhattacharya.



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**Applied Chemistry Laboratory**

23EE1108	BSC	Applied Chemistry Laboratory	0-0-2	1 Credit
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Teaching Scheme	Evaluation Scheme
Practical: 2 Hrs/week	CA1: 25 Marks CA2: 25 Marks

**Pre-Requisites:** 11<sup>th</sup> and 12<sup>th</sup> Science.

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Ability to determine the different parameters of given water sample.
CO2	Ability to prepare advanced polymer materials.
CO3	Experiment with different industrial compounds of coal material.
CO4	Demonstrate the different instrumental methods to analyze the given samples.

**List of Experiments:**

Sr. No.	Name of Experiment
1.	Determination of chloride content of water by Mohr's method.
2.	Determination of total hardness of water by EDTA method.
3.	Determination of dissolve oxygen of water by Winkler's method.
4.	Determination of alkalinity of water.
5.	Preparation of urea-formaldehyde resin.
6.	Determination of rate of corrosion of Aluminium in acidic and basic medium.
7.	Determination of moisture, volatile and ash content from coal by proximate analysis.
8.	pH metric Titration (Acid Base titration).
9.	Demonstration of photo-colorimeter / spectrophotometer.
10.	Conductometric Titration (Acid Base titration).



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**Basic Electronics Engineering Laboratory**

23EE1109	ESC	Basic Electronics Engineering Laboratory	0-0-2	1 Credit
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Teaching Scheme	Evaluation Scheme
Practical: 2 Hrs/week	CA1: 25 Marks CA2: 25 Marks

**Pre-Requisites:** Basic concepts of Physics.

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Demonstrate the function of different electronic instruments and diode applications.
CO2	Illustrate the different parameters of transistor (BJT).
CO3	Compare the applications of operational amplifiers.
CO4	Classify logic gates and Boolean algebra laws, various electronic appliances.

**List of Experiments:**

Sr. No	Name of Experiment
1.	Identification of circuit components, Breadboard and its connections.
2.	Study of CRO and measurement of voltage amplitude and frequency.
3.	To study the VI characteristics of P-N junction diode.
4.	To study the VI characteristics of Zener diode.
5.	To study Half wave rectifier with and without filter.
6.	To study Full wave rectifier with and without filter.
7.	To perform single stage amplifier using transistor.
8.	To study the Inverting and Non-inverting amplifier.
9.	To study the digital logic gates.
10.	To perform De-Morgan's theorem.



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### Basic Civil Engineering Laboratory

23EE1110	ESC	Basic Civil Engineering Laboratory	0-0-2	1 Credit
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Teaching Scheme	Evaluation Scheme
Practical: 2 Hr/week	CA1: 25 Marks CA2: 25 Marks

**Course outcome:** At the end of the course, students will be able to:

CO1	Identify building component and various sign conventions.
CO2	Explain linear measurements by using different instruments.
CO3	Measure area by using different instruments.

#### List of Experiments

Sr. No	Name of Experiment
1.	Site visit showing various building components.
2.	Drawing sheet showing various building elements.
3.	Drawing sheet showing various sign conventions.
4.	Plotting the outlines of building by chaining, ranging.
5.	Offsetting by using open and French Cross staff.
6.	Introduction to various leveling instrument.
7.	Plotting of closed traverse by compass.
8.	Measurement of area by planimeter.



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**Engineering Drawing Laboratory**

23EE1111	ESC	Engineering Drawing Laboratory	0-0-2	1 Credits
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Teaching Scheme	Evaluation Scheme
Practical: 2 Hrs/week	CA1: 25 Marks CA2: 25 Marks

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Solve projection of points, lines and plane planes with reference to principal.
CO2	Adopt basic knowledge of imagination and construction of various kinds of solids and development of its lateral surfaces.
CO3	Develop orthographic views of an object also make use of different basic commands of AUTOCAD to produce drawing in CAD
CO4	Construct isometric views of an object

**Term work:**

Students are supposed to draw/construct and submit all the sheets based on syllabus contents in the semester. (Sheet size-A2).

**List of Experiments**

Sr. No	Name of Experiment
1.	Lettering, Types of lines and methods of dimensioning and geometrical constructions.
2.	Projection of lines and planes.
3.	Development of lateral surfaces.
4.	Orthographic projections.
5.	Isometric projections.
6.	Orthographic projections on CAD software



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### Basic Electrical Engineering Laboratory

23EE1112	ESC	Basic Electrical Engineering Laboratory	0-0-2	1 Credit
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Teaching Scheme	Evaluation Scheme
Practical:2 Hrs/week	CA1-25 Marks CA2-25 Marks

**Pre-Requisites:** Applied Physics.

**Course Outcomes:** At the end of the course, students will be able to

CO1	Explain different meters and instruments for measurement of electrical quantities
CO2	Explain Basic methods of Earthing and study how to Measure earth resistance and insulation resistance by using megger.
CO3	Test for performance parameters of electrical machines.

#### List of Experiments:

Sr. No.	Name of Experiment
1.	Study of electric symbol and wiring components.
2.	Measurement of electrical quantities.
3.	Study of earthing.
4.	Verification of equivalent resistance for series and parallel circuit.
5.	Verify KVL and KCL.
6.	Speed control of DC motor.
7.	Perform open circuit and short circuit test on transformer
8.	Direction of rotation reversal of single phase induction motor.
9.	Use of megger for insulation testing and continuity test.
10.	Study of different types of lamps.



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### Workshop Practices

23EE1113	VSEC	Workshop practices	0-0-2	1 Credit
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Teaching Scheme	Evaluation Scheme
Practical: 2 Hrs/week	CA1: 25 Marks CA2: 25 Marks

**Pre-Requisites:** Basics of Mechanical Engineering.

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Make use of different tools for carpentry and welding operations with safety measures.
CO2	Develop skills in sheet metal and machine shop operations with safety measures.

**Evaluation:**

The evaluation consists of CA of each job and performance of work based on Workshop Practice syllabus. The term work also based on workshop diary and attendance of student.

**Instructions to the student:**

Each student is required to maintain a “workshop diary” consisting of drawing/sketches of the jobs and a brief description of tools, equipment and procedure used for doing the job.

**Course Contents:**

<b>Unit 1: Carpentry</b> Technical Terms related to wood working, Types of wood, Joining materials, Types of joints - Mortise and Tenon, Dovetail, Half Lap, etc., Methods of preparation and applications, carpentry tools like-Marking tools, cutting tools, planes, striking tools, holding tools, Carpentry operations-marking, sawing, chiseling, grooving etc. safety precautions.
<b>Unit 2: Welding</b> Arc welding- Welding joints, Edge preparation, Welding tools and equipment, Electrode classification and coding, Safety precautions.
<b>Unit 3: Sheet metal work</b> Specifications of metal sheets, working tools, Simple development and sheet metal operations like-cutting, bending, folding, punching, riveting and joining by brazing and soldering, Sheet metal machines- Bending Machine, Sheet metal joints, safety precautions.
<b>Unit 4: Machine shop:</b> Lathe machine, types of lathes, major parts, cutting tool, turning, facing and drilling operations, safety precautions.
<b>List of Experiments:</b> 1. Wood sizing exercises in planning, marking, sawing, chiseling and grooving to make different types of joint. 2. Exercise in Arc welding to make a joint. 3. Making a small parts using GI sheet involving development ,marking, cutting, bending,



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- brazing and soldering operations-i) Tray ii) Dustbin iii) funnel, etc. and similar articles  
4. A job on turning of a Mild Steel cylindrical job using center lathe.

**Reference Books:**

1. A Course in Workshop Technology, Vol-I by B.S. Raghuvanshi, Dhanapat Rai and Sons.
2. Elements of Workshop Technology, Vol-I by Hajara Chaudhari, Media Promoters.
3. Workshop Technology, Vol-I by Gupta and Kaushik, New Heights.
4. Workshop Technology, Vol-I by Chapman, The English Language Book Society.
5. Workshop Technology, Vol.-I by H.S. Bawa, TMH Publications, New Delhi.
6. K.C. John, Mechanical Workshop Practice ,Prentice Hall Publication, New Delhi,2010



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**Electrical Workshop**

23EE1114	VSEC	Electrical Workshop	0-0-2	1 Credit
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Teaching Scheme	Evaluation Scheme
Practical: 2 Hrs/week	CA1: 25 Marks CA2: 25 Marks

**Pre-Requisites:** Nil

**Course Outcomes:** At the end of the course, students will be able to:

CO1	To define various electrical measuring instruments and symbols.
CO2	To define Switch and its connections.
CO3	To explain residential distribution system and types of lamps.
CO4	To explain Types of wiring, Electrical materials and star rating of equipment's.

**Evaluation:**

This course provides hand-on experience in Electrical measuring Instruments, Switches and its connections, types of lamps and different wiring connections.

**Instructions to the student:**

Each laboratory table is equipped with a Power supply, Voltmeter, Ammeter, Watt meter, Digital Multimeter, Hand tool kit for circuit assembly, soldering station, components and PCBs. Students work in groups of four, but maintain individual laboratory notebooks and submit individual reports.



**Course Contents:**

**Unit 1: Introduction to Basics of Electrical Symbols and Measuring Instruments**

Study of different electrical symbols, Study of measuring instruments voltmeter, Ammeter, Watt meter, Multimeter

**Unit 2: Electrical Switches and Switchboard Connection**

Different types of electrical switches- Piano switch, Tumbler switch, Two way switch, Push buttons, Double and Triple pole Switch and switchboard connection.

**Unit 3: Residential Distribution system**

Concept of distribution system, Sub-circuit, MCB, Fuse.

**Unit 4: Different types of Lamps**

Incandescent, Fluorescent, Sodium vapor, Metal halide lamp.

**Unit 5: Types of Wiring, Electrical Materials and Star rating**

Stair case and go down wiring, Study of electrical materials, Star rating of equipment, Calculation of electrical energy bill.

**List of Experiments:**

1. Study of electrical symbols
2. Study of electrical measuring Instruments (Voltmeter, Ammeter, Wattmeter, Multimeter).
3. Study of different types of electrical switches and switchboard connection.
4. Study of single one lamp single switch control and two lamp two switch lamp control.
5. Study of residential distribution system.
6. Study of lamps.
7. Study of stair case and go down wiring.
8. Study of electrical materials (conductor, cables, insulator).
9. Study of star rating of equipment.
10. Study of calculation of electrical energy bill.



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### Applied Mathematics-II

23EE1201	BSC	Applied Mathematics-II	3-1-0	4 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 Hrs/week Tutorial: 1 Hr/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks

**Pre-Requisites:** HSC Mathematics.

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Apply the reduction formula to evaluate definite integral and develop the ability to trace the curve for a given equation of curve and its nature.
CO2	Apply the concept of change of variable and change of order of integration to evaluate multiple integral and their usage in computing area and volumes.
CO3	Apply the concept of O.D.E.to solve first order linear and exact differential equations.
CO4	Apply the first order linear and exact differential equations to solve the problems related to electric circuit, mechanical system etc.
CO5	Solve the first order and first degree differential equations numerically.
CO6	Solve higher order linear differential equations with constant coefficients.

**Course Contents:**

<b>Unit 1: Curve tracing and Reduction formulae</b> Reduction formulae: $\int_0^{\frac{\pi}{2}} \sin^n x dx$ , $\int_0^{\frac{\pi}{2}} \cos^n x dx$ and $\int_0^{\frac{\pi}{2}} \sin^m x \cos^n x dx$ (m and n are positive integers) and problems. Tracing of the curves given in Cartesian and polar forms; Rectification of plane curves in Cartesian and Polar form.	<b>[8]</b>
<b>Unit 2: Multiple integrals and its application</b> Double integration in Cartesian and polar co-ordinates, Evaluation of double integrals by changing the order of integration and changing to polar form, Triple integral, Area enclosed by plane curves, Mass of a plane lamina.	<b>[8]</b>
<b>Unit 3: Ordinary differential equation of first order and first degree</b> Introductory remarks- Order, Degree and formation of differential equations, Linear differential equations, Reducible to Linear differential equations, Exact differential equations, Reducible to exact differential equations.	<b>[6]</b>
<b>Unit 4: Applications of ordinary differential equation of first order and first degree</b> Application to electric circuit, Orthogonal trajectories, Newton's law of cooling and rate of decay and growth.	<b>[6]</b>
<b>Unit 5: Numerical solution of ordinary differential equations of first order and first degree</b> Numerical solution by Picard's method, Taylor's series method, Euler's method, Modified Euler's method and Runge-Kutta fourth order formula	<b>[6]</b>
<b>Unit 6: Linear differential equations with constant coefficients</b> Introductory remarks- Complementary function, particular integral; Rules for finding	<b>[8]</b>



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complementary function and Particular integral; Method of variation of parameters; Cauchy's homogeneous and Legendre's linear differential equation.	
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**Textbooks:**

1. P. N. Wartikar and J. N. Wartikar: A Text Book of Applied Mathematics (Vol I and II), Pune Vidyarthi Griha Prakashan, Pune.
2. N. P. Bali: A Text Book of Engineering Mathematics, Laxmi Publications, New Delhi.
3. Peter O' Neil: A Text Book of Engineering Mathematics, Thomson Asia Pvt. Ltd., Singapore.

**Reference Books:**

1. B. S. Grewal: Higher Engineering Mathematics, Khanna Publishers.
2. Erwin Kreyszig: Advanced Engineering Mathematics, John Wiley and Sons.
3. B. V. Ramana: Higher Engineering Mathematics, McGraw-Hill Publications, New Delhi
4. C. R. Wylie and L. C. Barrett: advanced Engineering Mathematics, McGraw Hill Publishing Company Ltd.



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### Applied Physics

23EE1202	BSC	Applied Physics	2-0-0	2 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 2 Hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks

**Pre-Requisites:** Basic concepts of optics, solid state physics and modern physics.

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Apply the basic of interference, diffraction, polarization for their engineering applications.
CO2	Make use of laser technology and optical fibers in various disciplines.
CO3	Explain the basic concepts of rotational motion and pendulum.
CO4	Apply the knowledge of crystallography to study various engineering materials
CO5	Solve the problems by applying the basics of semiconductors and dielectrics.
CO6	Summarize the basic knowledge of nanotechnology and Nano-materials.

**Course Contents:**

<b>Unit 1: Interference, diffraction and polarization</b> Introduction, Interference of light in thin films, Diffraction grating construction theory, Derivation of measurement of wavelength using diffraction grating, Polarization of light, Methods of production of polarized light, Huygens theory of double refraction.	<b>[5]</b>
<b>Unit 2: LASER and fibre optics</b> Introduction, Principle of laser, Types of laser, Population inversion and pumping, Applications of laser, Introduction of optical fibre, Structure of optical fibre, Propagation mechanism of light through optical fibre, applications of optical fibre.	<b>[5]</b>
<b>Unit 3: Rotational motion and pendulum</b> Introduction, Analogy of rotational motion with translational motion, Moment of inertia of a spherical shell and solid cylinder, Motion of spherical shell and solid cylinder rolling down an inclined plane, Compound pendulum, Kater's pendulum and Bessel's formula.	<b>[5]</b>
<b>Unit 4: Crystallography</b> Introduction, Space lattice and seven crystal system, Unit cell, Bravais lattice, Properties of cubic unit cell, Relation between lattice constant and density, Lattice planes and Miller indices, Interplanar spacing for cubic system, X-ray diffraction, Bragg's law, X-ray spectrum.	<b>[5]</b>
<b>Unit 5: Semiconductor and dielectrics</b> Introduction, Intrinsic and extrinsic semiconductor, Conductivity of semiconductor, Hall Effect, Application of semiconductor, Introduction of dielectrics, Dielectric parameters, Types of polarization, Dielectric materials, Frequency and temperature dependence of dielectric materials.	<b>[5]</b>
<b>Unit 6: Nanophysics</b>	<b>[5]</b>



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Introduction, Top down and bottom up approach for synthesis of nonmaterial's, Length scales relevant to nanoscience, Carbon nanotubes (CNTs)- structure and types, Properties and applications of CNTs, Applications of Nanophysics, Scanning electron microscopy, Transmission electron microscopy,

**Textbooks:**

1. M. N. Avadhanulu and P.G. Kshirsagar, A Textbook of Engineering Physics, S Chand Publication 2007.
2. B. K. Pandey and S. Chaturvedi, Engineering Physics: – Cengage Publications.
3. N.S. Khare and S. Kumar. A text Book of properties of matter, Atmaram and sons New Delhi.

**Reference Books:**

1. Geometrical and Physical optics by D. S. Mathur.
2. Laser and Non-linear optics by B.B. Laud.
3. S. O. Pillai, Solid State Physics.
4. Physics- S.G. Starling and Woodal Longmams and Green Co. Ltd.
5. R. K. Gaur and S. L. Gupta, Engineering Physics, Dhanpat Rai Publications.
6. C.M. Srivastava and C. Srinivasan, Science of Engineering Materials, Wiley publication.
7. Nanotechnology, Dr. Sulbha K Kulkarni, Capital Publishing Co, 2011, Second Ed.



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### Communication Skills

23EE1203	AEC	Communication Skills	1-0-0	1 Credit
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Teaching Scheme	Evaluation Scheme
Lectures: 1 Hrs/week	CA1: 5 Marks CA2: 5 Marks Mid Semester Examination: 15 Marks End Semester Examination: 25 Marks

**Pre-Requisites:** Basic knowledge of English language with grammar.

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Illustrate concept of communication and its process
CO2	Relate the knowledge of reading and listening skills
CO3	Apply the knowledge of oral communication and presentation skills
CO4	Make use of grammar correctly.

#### Course Contents:

<b>Unit 1: Fundamentals of communication</b> Nature and importance of communication, process of communication, types and functions of communication, Types of barriers to communication and solutions to overcome it.	<b>[3]</b>
<b>Unit 2: Effective comprehension skills</b> <b>Listening:</b> Importance of listening, Types of listening, Barriers to listening and techniques for effective listening. <b>Reading:</b> Introduction to reading, Types of reading, Barriers to reading	<b>[3]</b>
<b>Unit 3: Oral communication skills</b> Features of effective oral communication, Appropriate use of non-verbal communication, Group discussion, Public speaking, Job Interview, Telephonic etiquettes.	<b>[3]</b>
<b>Unit 4: Basic English grammar</b> Articles, Sentence formation and sentence structures, Aspects of tenses, Subject-verb agreement, Use of auxiliaries and modal auxiliaries, Common errors.	<b>[3]</b>
<b>Textbooks:</b> 1. Sanjay Kumar, Pushpalata, Communication Skills, Oxford University Press, 2016 2. Meenakshi Raman, Sangeeta Sharma, Technical Communication: Principles and Practice, Oxford University Press, 2017. 3. M Ashraf Rizvi, Effective Technical Communication, Tata McGraw Hill, New Delhi.	
<b>Reference Books</b> 1. Bovee Courtland, L and Thrill, John V. Business Communication, Tata McGraw Hill, New York, Taxman Publication (1989). 2. G.S. Kushwaha, English Phonetics and Pronunciation for Indian Learners, Notion Press.	



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**Fundamentals of Mechanical Engineering**

23EE1204	ESC	Fundamentals of Mechanical Engineering	1-0-0	1 Credit
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Teaching Scheme	Evaluation Scheme
Lecture: 1 Hr/week	CA1: 5 Marks CA2: 5 Marks Mid Semester Examination: 15 Marks End Semester Examination: 25 Marks

**Pre-Requisites:** General Physics and Chemistry

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Describe Various thermodynamic systems and laws of thermodynamics.
CO2	Explain different types of links, mechanisms and machines in mechanical engineering.
CO3	List different types of manufacturing processes and different engineering materials.
CO4	Describe different power plants and Energy conversion devices.

**Course Contents:**

<p><b>Unit 1: Introduction to thermal engineering</b>            Thermodynamic State, Process, cycle, Thermodynamic system, Heat, work, Internal Energy, Zeroth law, First law of thermodynamics and its application to various mechanical elements, Limitations of first law of thermodynamics, Introduction to IC Engine: Construction and working of C.I. and S.I. engine, two stroke and four stroke cycles, Introduction to Refrigeration and Air conditioning: Vapour compression and Vapour absorption system, window Air conditioning (Descriptive treatment only).</p>	<b>[3]</b>
<p><b>Unit 2: Introduction to machine, gear train and its application</b>            Difference between machine and structure, Definition of link, Pair, Kinematic chain, Different motions involved in Mechanisms, types of gears and gear trains, study of different machines such as Drilling, Lathe, Milling.</p>	<b>[3]</b>
<p><b>Unit 3: Introduction to manufacturing processes</b>            Casting Process, Steps involved in sand casting process, Metal removing processes: Turning, Drilling, Milling, Boring, Grinding, Super finishing operations (Applications of each metal removing process), Metal Joining processes: Introduction to Welding, Soldering, and Brazing Process (Applications of each metal joining process), Materials used in engineering and their applications: Metals- Ferrous and Non-Ferrous, Non-metallic materials, material selection criteria.</p>	<b>[3]</b>
<p><b>Unit 4: Introduction to power plants and energy conversion devices</b>            Power Plants: Solar, Steam, Hydroelectric, Nuclear, Bio-Diesel Power plants (Descriptive treatment only) Energy conversion devices: Pumps, Compressors, Turbine.</p>	<b>[3]</b>
<p><b>Textbooks:</b>            1. Thermal Engineering by R.K. Rajput, Laxmi publication, Delhi.            2. Engineering Thermodynamics by Achultan, Prentice Hall of India.</p>	



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3. Elements of Heat Engine Vol.I,II,III by patel and karamchandani, Acharya Book Depot.
4. Elements of Workshop Technology, Vol.I and II by Hajara Choudhari, Media Promoters.
5. Theory of Machines by S.S. Ratan.
6. Internal combustion Engine by V. Ganesan, Tata McGraw-Hill Publication
7. Power plant Engineering by arora and Domkunwar, Dhanpatrai and sons publication.

**Reference Books:**

1. Manufacturing Technology Volume I and II by P.N. Rao, Tata McGraw-Hill Publication.
2. Basic Mechanical Engineering by Basant Agrawal and C.M.Agrawal, Wiley India Pvt Ltd.
3. S. Hall, A.R. Holowenko, H.G. Langhlin, "Theory and Problems of Machine Design.", Schaum's outline series, Tata McGraw-Hill book company, New York, 1982.



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### Engineering Mechanics

23EE1205	ESC	Engineering Mechanics	2-0-0	2 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 2 Hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Examination: 30 Marks End Semester examination: 50 Marks

**Pre-Requisites:** Basic concepts of physics and mathematics.

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Apply the fundamental laws of mechanics.
CO2	Make use of concept of statics equilibrium.
CO3	Solve the various types of frames.
CO4	Find the centroid and moment of inertia.
CO5	Apply the knowledge of kinematics and kinetics.
CO6	Explain the concept of work, energy and impact.

**Course Contents:**

<b>Unit 1: Fundamentals of statics</b> Basic terms in mechanics, Fundamental law's of mechanics. Force, Moment and couple, system of forces, Characteristics of force, Resultant, Resolution and composition of forces, Varignon's theorem.	<b>[5]</b>
<b>Unit 2: Equilibrium</b> Equilibrium of forces, analytical conditions of equilibrium, Free body diagram, Lami's theorem, Beam, Types of beams, types of supports, types of load, Analysis of beams reactions	<b>[5]</b>
<b>Unit 3: Analysis of frames (Truss)</b> Types of frames, Assumptions, Methods of analysis:- method of joints (for plane trusses), method of sections (for plane trusses).	<b>[5]</b>
<b>Unit 4: Centroid and moment of inertia</b> Centroid and center of gravity, Moment of inertia of standard shapes, Parallel and perpendicular axis theorem, Moment of inertia of plain and composite figures, Radius of gyration.	<b>[5]</b>
<b>Unit 5: Dynamics</b> Types of motion, Introduction to kinematics of linear motion (Constant and variable acceleration), Acceleration due to gravity, Kinetics of linear motion- D'Alembert's principle, Impulse momentum principle.	<b>[5]</b>
<b>Unit 6: Work, energy and impact</b> Impact, Types of Impact, Principle of conservation of momentum, Coefficient of restitution, Numerical on direct central Impact, Work, Energy, Power, Work- Energy equation, Loss of kinetic energy.	<b>[5]</b>



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**Textbooks:**

1. Engineering Mechanics by S. S. Bhavikattis, New Age International Pvt. Ltd.
2. Engineering Mechanics by R. S. Khurmi, S. Chand Publications).
3. Engineering Mechanics by R. K. Bansal and Sanjay Bansal.

**Reference Books:**

1. Vector Mechanics for Engineers Vol-I and II by F. P. Beer and E. R. Johnston, Tata McGraw Hill Publication.
2. Engineering Mechanics by Irving H. Shames, Prentice Hall of India, New Delhi.
3. Engineering Mechanics by Statics and Dynamics by Ferdinand Singer, Harper and Row Publications.
4. Applied Mechanics- Dynamics and Statics by I.B. Prasad, Khanna Publisher, Delhi.



### Fundamentals of Electrical Circuits

23EE1206	PCC	Fundamentals of Electrical Circuits	2-0-0	2 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 2 Hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Examination: 30 Marks End Semester examination: 50 Marks

**Pre-Requisites:** Basic Electrical Engineering.

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Interpret the concept of electrical circuits to simplify the circuits using voltage division techniques, current division technique.
CO2	Determine the current, voltage and equivalent resistance by using network reduction techniques.
CO3	Determine the current through any element and voltage across through any element, for a given network using mesh analysis, nodal analysis, superposition theorem.
CO4	Interpret the response of series and parallel RL, RC circuit with sinusoidal source.
CO5	Explain the three phase AC circuits.
CO6	Explain the methods of measurement of power in 3-phase circuits.

**Course Contents:**

<b>Unit 1: Basics of circuits</b> Types of elements, Types of networks, Ohm's law (numerical), Voltage division techniques, Current division technique (Numerical).	<b>[5]</b>
<b>Unit 2: DC circuits</b> Kirchhoff's laws, Series circuits, Parallel circuits, Series-Parallel circuits, Source transformation, Numerical.	<b>[5]</b>
<b>Unit 3: Network theory</b> Mesh analysis, Nodal analysis, Superposition Theorem, Numerical only with independent sources.	<b>[5]</b>
<b>Unit 4: AC circuits</b> Resistance connected across a sinusoidal source, Inductor connected across a sinusoidal source, Capacitor Connected across a Sinusoidal Source, Series R-L circuit connected across a Sinusoidal source, Series R-C circuit connected across a sinusoidal source, Parallel R-L circuit connected across a sinusoidal source, Parallel R-C circuit connected across a sinusoidal source, Numerical.	<b>[5]</b>
<b>Unit 5: Three phase ac circuits</b> Three phase voltage and current, Star (Y) connection, Delta ( $\Delta$ ) connections, Three phase power, Star-Delta conversion.	<b>[5]</b>
<b>Unit 6: Three phase power measurement</b> Measurement of power in 3-phase circuits: Three Wattmeter method, Two Wattmeter method, one Wattmeter method, Measurement of reactive power.	<b>[5]</b>



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**Textbooks:**

1. Charles K. Alexander and Matthew N. O. Sadiku, Fundamentals of Electric Circuits, McGraw Hill, 2022
2. Robert L. Boylestad, Introductory Circuit Analysis, Pearson, 2019
3. William H. Hayt Jr., Jack E. Kemmerly and Steven M. Durbin, Engineering Circuit Analysis, McGraw Hill, 2019
4. J. David Irwin and R. Mark Nelms, Basic Engineering Circuit Analysis, Wiley, 2021.

**Reference Books:**

1. Richard C. Dorf and James A. Svoboda, Introduction to Electric Circuits, Wiley, 2020
2. D.P. Kothari and I.J. Nagrath, Basic Electrical Engineering, Tata McGraw Hill, 2019
3. V.K. Mehta and Rohit Mehta, Principles of Electrical Engineering and Electronics, S. Chand Publishing, 2016
4. Mittle and Mittal, Basic Electrical Engineering, Tata McGraw Hill, 2017
5. S.K. Bhattacharya, Basic Electrical and Electronics Engineering, Pearson, 2011
6. J.B. Gupta, Fundamentals of Electrical Engineering and Electronics, S.K. Kataria and Sons, 2015
7. U.A. Bakshi and A.P. Godse, Electrical Circuits, Technical Publications, 2014.



### Problem Solving Using C Programming

23EE1207	VSEC	Problem Solving Using C Programming	2-0-0	2 Credits
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Teaching Scheme	Evaluation Scheme
Lecture:2 Hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Examination: 30 Marks End Semester Examination: 50 Marks

**Pre-Requisites:** Basics of Algorithm and flow chart

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Outline basic terminologies used in C Programming.
CO2	Demonstrate the fundamentals of control structures in C programming.
CO3	Demonstrate the concept of arrays and string handling functions.
CO4	Apply concepts of functions.
CO5	Apply concepts of structures.
CO6	Apply concepts of pointers.

**Course Contents:**

<b>Unit 1: Basics of C</b> Algorithm, Flowchart, Introduction of C, History and features of C, Basic structure of C program, Role of compiler and interpreter, Building an executable version of a C Program, Data type, Tokens- Identifiers, Keywords, Constants, Operators, Special characters and strings, Formatted input/output function, Reading/Writing characters.	<b>[5]</b>
<b>Unit 2: Control statements in C</b> Simple if, if-else Statement, Nesting of if-else, if-else ladder, Switch statements, while loop, do-while loop, for loop.	<b>[5]</b>
<b>Unit 3: Arrays in C</b> What and Why? One dimensions arrays; Multi dimensions arrays-Two dimensions arrays, Reading string from terminal, Writing string to screen, String handling functions.	<b>[5]</b>
<b>Unit 4: Functions in C</b> Function definition, Advantage of function, Types of function- built-in function, User defined function, Categories of function, Recursion, Variable storage class	<b>[5]</b>
<b>Unit 5: Structures in C</b> Basics of structure, Advantage of structure, Size of structure, Array of structures, Structure and function, Defining unions.	<b>[5]</b>
<b>Unit 6: Pointer in C</b> Introduction to pointer, Pointer expressions, Pointer and arrays, Pointers to functions-call by reference, Structures and pointer.	<b>[5]</b>
<b>Textbooks:</b>	
1. "Let us C" by Yashwant Kanetkar	
2. Computing Fundamentals and C Programming   2nd Edition, by E Balagurusamy	



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**Reference Books:**

1. The C Programming Language by Brian Kernighan and Dennis Ritchie.
2. C: The Complete Reference by By Herbert Schildt.



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**Applied Physics Laboratory**

23EE1208	BSC	Applied Physics Laboratory	0-0-2	1 Credit
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Teaching Scheme	Evaluation Scheme
Practical: 2 Hrs/week	CA1: 25 Marks CA2: 25 Marks

**Pre-Requisites:** Basic concepts of optics, solid state physics and modern physics.

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Understand the I-V characteristic and band gap energy of semiconductor.
CO2	Understand the basic concept of LASER and fibre optics.
CO3	Demonstrate the knowledge of motion and pendulum, grating and crystal structure.
CO4	Develop the basic knowledge of Hall effect, Ultrasonic Interferometer and Newton's ring.

**List of Experiments:**

Sr. No	Name of Experiment
1.	To determine the wavelength of monochromatic light using Newton's rings.
2.	To find the wavelength of light with the help of plane diffraction grating.
3.	To determine the wavelength of He-Ne laser light using plane diffraction grating.
4.	To calculate numerical aperture of optic fibre by laser diode.
5.	To calculate the moment of inertia of a disc using auxiliary annular ring.
6.	To determine the acceleration due to gravity by using Kater's pendulum.
7.	To analyze crystal structure and miller indices of various planes.
8.	To determine the Hall coefficient of a given current carrying conductor.
9.	To determine band gap energy of given semiconductor.
10.	To study I-V characteristics of P-N junction diode.



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**Communication Skills Laboratory**

23EE1209	AEC	Communication Skills Laboratory	0-0-2	1 Credit
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Teaching Scheme	Evaluation Scheme
Practical: 2 Hrs/week	CA1: 25 Marks CA2: 25 Marks

**Pre-Requisites:** Basic knowledge of English language with grammar.

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Develop received pronunciation with stress and intonation.
CO2	Take part in group discussion, elocution and debate.
CO3	Utilize writing skills effectively.
CO4	Make use of presentation and interview techniques effectively.

**List of Experiments:**

Sr. No.	Name of Experiment
1.	Ice breaking: Problems I face while communicating (LSRW).
2.	Vocabulary building: Activities and games.
3.	Introduction to phonetic symbols (Consonants, Vowels and diphthongs).
4.	Pronunciation/transcription from the dictionary.
5.	Stress and intonation.
6.	Elocution and extempore.
7.	Group discussion and Debate.
8.	Interview techniques.
9.	Letter writing with resume.
10.	Presentation techniques.



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**Fundamentals of Mechanical Engineering Laboratory**

23EE1210	ESC	Fundamentals of Mechanical Engineering Laboratory	0-0-2	1 Credit
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Teaching Scheme	Evaluation Scheme
Practical: 2 Hrs/week	CA1: 25 Marks CA2: 25 Marks

**Pre-Requisites:** Basic concepts of Physics and chemistry

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Demonstrate I.C Engine and explain working of two stroke four stroke engine
CO2	Explain working of vapor compression refrigeration system and window air conditioner
CO3	Demonstrate Gear and gear trains and explain working of lathe, drilling machine
CO4	Choose Engineering materials with their applications and explain working of power plants and energy conversion devices

**List of Experiments:**

Sr. No	Name of Experiment
1.	Demonstration of I.C. Engine
2.	Demonstration of two stroke and four stroke engine
3.	Demonstration of vapor compression refrigeration system and window air conditioner
4.	Demonstration of types of gears and gear trains
5.	Demonstration of operations of center lathe (turning, step turning, facing, boring, taper turning, knurling, grooving, threading.)
6.	Demonstration of operations on drilling machines (drilling, reaming, spot facing, counter boring)
7.	Case study on engineering materials and their applications
8.	Demonstration of solar water heating system
9.	Demonstration of pumps and compressors
10.	Industrial visit based on syllabus



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**Engineering Mechanics Laboratory**

23EE1211	ESC	Engineering Mechanics Laboratory	0-0-2	1 Credit
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Teaching Scheme	Evaluation Scheme
Practical: 2 Hrs/week	CA1: 25 Marks CA2: 25 Marks

**Pre-Requisites:** Basic concepts of physics and mathematics.

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Make use of the equilibrium concept.
CO2	Identify support reaction, centroid and Coefficient of friction.
CO3	Solve the problems on resultant, support reaction and truss by graphical method.

**List of Experiments:**

Sr. No.	Name of Experiment
1.	Polygon law of forces.
2.	Lami's theorem.
3.	Bell Crank Lever.
4.	Jib Crane Apparatus.
5.	Support reaction for beam.
6.	Centroid of irregular shaped bodies.
7.	To determine coefficient of friction.
8.	Graphical method to determine resultant.
9.	Graphical method to determine support reaction for beam.
10.	Graphical method to determine the forces in truss.



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### Problem Solving Using C Programming Laboratory

23EE1212	VSEC	Problem Solving Using C Programming Laboratory	0-0-2	1 Credit
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Teaching Scheme	Evaluation Scheme
Practical: 2 Hrs/week	CA1: 15 Marks CA2: 15 Marks End Semester Examination: 20 Marks

**Pre-Requisites:**

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Design algorithm and flow chart for logical solution.
CO2	Develop the programs on the basic programming concepts.
CO3	Understand the syntax and develop programs based on control structures.
CO4	Demonstrate the knowledge of array and structure and develop programs.
CO5	Develop the programs on user defined functions.
CO6	Demonstrate the knowledge of pointer and develop programs.

**List of Experiments:**

Sr. No	List of Experiment
1.	Simple program to display message.
2.	Program to display data using '\n' and '\t'.
3.	Program to Calculate area of circle by using constant.
4.	Program to perform arithmetic operators.
5.	Program using conditional operator.
6.	Program to check person is eligible for voting using simple if statement.
7.	Program to check no. is even or odd using if else statement.
8.	Program to check no. is divisible by 2 and 5 using logical operators.
9.	Program to check no. is positive or negative or zero using if else ladder.
10.	Program to find largest no. from three nos using nested if else.
11.	Program to create calculator using switch case.
12.	Program to check alphabet is vowel or consonant using switch case.
13.	Program to display 1 to n numbers in reverse order.
14.	Program to calculate addition of 1 to n numbers.
15.	Program to calculate sum of digit.
16.	Program to check no is palindrome or not.
17.	Program to check no. is prime or not.
18.	Program to calculate factorial of given number.



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19.	Program to display Fibonacci series.
20.	Program on nested for loop.
21.	Program to traversing 1D array.
22.	Program to calculate addition of elements of array.
23.	Program to find largest number from array.
24.	Program to traversing 2D array.
25.	Program to calculate addition of two 2D arrays.
26.	Program on string handling functions.
27.	Program to calculate multiplication of two nos using without argument and without return.
28.	Program to calculate division of two nos using without argument and with return.
29.	Program to calculate area of rectangle using with argument and without return.
30.	Program to calculate area of triangle using with argument and with return.
31.	Program to calculate square and cube of no. using two different functions.
32.	Program to calculate factorial of no using recursion.
33.	Program to calculate sum of 1 to n numbers using recursion
34.	Program to implement Student structure take data from user and display.
35.	Program to implement Employee structure take data from of 3 employees and display.
36.	Program to display address and value of different data types using pointer.
37.	Program to calculate division of two nos using pointer.
38.	Program to calculate sum of elements of array using pointer.
39.	Program to implement call by reference.
40.	Program on structure and pointer.



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## **Teaching and Evaluation Scheme for SY B. Tech**

**Department of Electrical Engineering**  
**Semester: III**





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**Department:** Electrical Engineering

**Rev:** Course Structure/00/NEP/2023-24

**Class:** S.Y. B. Tech.

**Semester:** III

Course Code	Course Type	Course	Teaching Scheme				Evaluation Scheme					Credits
			L	T	P	Total Hrs.	CAI	CAII	MSE	ESE	Total	
23EE2301	PCC	Network Analysis	3	-	-	3	10	10	30	50	100	3
23EE2302	PCC	Measurement and Instrumentation	3	-	-	3	10	10	30	50	100	3
23EE2303	PCC	DC Machines and Transformers	3	-	-	3	10	10	30	50	100	3
23EE2304	EEM	Project Management	2	-	-	2	25	25	-	-	50	2
23EE2305	MC	Environmental Sciences	2	-	-	2	25	25	-	-	50	Audit
23EE2306	PCC	Network Analysis Laboratory	-	-	2	2	25	25	-	-	50	1
23EE2307	PCC	Measurement and Instrumentation Laboratory	-	-	2	2	15	15	-	20	50	1
23EE2308	PCC	DC Machines and Transformers Laboratory	-	-	2	2	15	15	-	20	50	1
23EE2309	CEP	Mini Project-II	-	-	2	2	25	25	-	-	50	1
23OEEE21	OEC	Open Elective Course – I	2	-	-	2	10	10	30	50	100	2
23EEMDXX	MDM	Multidisciplinary Minor- I	2	-	-	2	10	10	30	50	100	2
23HSSM01	VEC	Aptitude Skills-I	1	-	-	1	25	25	-	-	50	1
23HSSM02	VEC	Language Skills-I	-	-	2	2	25	25	-	-	50	1
<b>Total</b>			<b>18</b>	<b>-</b>	<b>10</b>	<b>28</b>	<b>230</b>	<b>230</b>	<b>150</b>	<b>290</b>	<b>900</b>	<b>21</b>

**Multidisciplinary Minor-I**

Electrical System Design <b>(Basket - A)</b>	Automation and IOT <b>(Basket - B)</b>	Renewable Energy Sources and Grid Integration <b>(Basket - C)</b>
Electrical System Planning and Design (23EEMDA1)	Introduction to PLC (23EEMDB1)	Energy Storage Systems (23EEMDC1)

\*Open Elective course will be offered to students of other programs and will not be offered to students of the same program.



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### Network Analysis

23EE2301	PCC	Network Analysis	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Basic Electrical Engineering, Fundamentals of Electrical Circuits.

**Course Outcomes:**

At the end of the course, the students will be able to:

CO1	Analyze the performance of the network by determining the equivalent circuits using Thevenin's and Norton's theorems, maximizing power transfer using Maximum Power Transfer theorem, Reciprocity, Tellegen's and Millman's theorem for the electrical networks with DC excitation.
CO2	Apply the properties of Laplace Transform in circuit analysis to solve complex circuit problems.
CO3	Apply the Inverse Laplace Transform to solve numerical problems involving simple poles, repeated poles, and complex poles and analyse the properties of the Inverse Laplace Transform.
CO4	Solve initial and final conditions in RL, RC, and RLC circuits for both AC and DC excitations and analyse circuit elements under switching conditions.
CO5	Apply graph theory to analyse network topology and develop associated matrices, including incidence matrix, fundamental loop and cutset matrices.
CO6	Solve Z and Y parameters, ABCD and h parameters of two-port networks.

**Course Contents:**

<b>Unit 1: Network Theorems</b> Thevenin's and Norton's theorems, Duality, Maximum Power transfer theorem, Millman's theorems, Reciprocity Theorem, and Tellegen's theorem.	[6]
<b>Unit2: Laplace Transform in Circuit Analysis:</b> Laplace Transform, Properties of Laplace Transform, Circuit Analysis using Laplace Transform, Advantages, Disadvantages and Applications of Laplace Transform in Circuit Analysis, Simple Numerical Problems	[6]
<b>Unit 3: Inverse Laplace Transforms</b> The Inverse Laplace Transform: Simple Poles, Repeated Poles, Complex Poles; Inverse Laplace Transform Theorem: Linearity Theorem, Shifting Theorem, Convolution Theorem, Properties of Inverse Laplace Transform, Advantages, Disadvantages and Applications of Inverse Laplace Transform, Simple Numerical Problems	[6]
<b>Unit 4: Transient Analysis</b> Behavior of circuit elements under switching condition and their Representation, Evaluation	[6]



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of initial and final conditions in RL, RC and RLC circuits for AC and DC excitations with Laplace transforms.	
<b>Unit 5: Network Topology</b> Basic Terminology: Graph, Types of Graphs, Planar and Non-Planar Graph, Tree, Co-tree, Matrices Associated with Network Graphs: Incidence Matrix, Fundamental Loop Matrix, Fundamental Cutset Matrix with examples,	[6]
<b>Unit-6: Two Port Network Parameters</b> Concept of complex frequency, Transform impedance and transform admittance; Definition and classification of Two port network parameters: Z, Y, h and Transmission parameters, relationship between parameters sets, Interconnections of Two-Port Network, condition for symmetry and reciprocity, numerical problems.	[8]
<b>Textbooks:</b> 1. M.E. Van Valkenberg, Network Analysis, Prentice Hall of India, 3 <sup>rd</sup> Edition, 2000. 2. Charles K Alexander and Mathew N O Sadiku, Fundamentals of Electric Circuits, TMH, 3 <sup>rd</sup> Edition, 2009.	
<b>Reference Books:</b> 1. Hayt, Kemmerly and Durbin, Engineering Circuit Analysis, TMH, 7 <sup>th</sup> Edition, 2010. 2. J. David Irwin and R. Mark Nelms, Basic Engineering Circuit Analysis, John Wiley, 8 <sup>th</sup> Edition, 2006. 3. Roy Choudhury, Networks and Systems, 2 <sup>nd</sup> Edition, New Age International Publications, 2006. 4. Joseph A. Edminister, Mahmood Maqvi, "Theory and Problems of Electric Circuits", Schaum's Outline Series. 5. Robert L Boylestad, "Introductory Circuit Analysis", Pearson Publications.	



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### Measurement and Instrumentation

23EE2302	PCC	Measurement and Instrumentation	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1:10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Basic Electrical Engineering

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Analyze the characteristics of measuring instruments, types of errors, and classifications to ensure precise measurement and accurate data interpretation.
CO2	Evaluate different methods for measuring active and reactive power, and calibrate energy meters to enhance efficiency in electrical circuits.
CO3	Apply various techniques to measure resistance, inductance, and capacitance using Wheatstone Bridge, Kelvin's Double Bridge, and other methods for practical electrical
CO4	Differentiate between various types of transducers and select appropriate sensors for specific applications in data acquisition and automation.
CO5	Demonstrate the functionality of digital meters, including frequency meters, digital LCR meters, and microprocessor-based instruments for automation and precise measurements.
CO6	Interpret the working principles of storage and display devices such as DSO, CRO, Power Analyzer, and Spectrum Analyzer to analyse waveforms and optimize electrical signal representation.

#### Course Contents:

<b>Unit 1: Characteristics of measuring instruments</b> Characteristics of measuring instruments, Errors and its types, Classification of instruments, Standards, torque in measuring instruments, Construction and working principle advantages and disadvantages of Permanent Magnet Moving Coil (PMMC), Moving Iron (MI) and Dynamometer type instruments, shunt and multipliers for range extension of MI Instruments (Numerical)	[6]
<b>Unit 2: Measurement of Power and Energy</b> Measurement of active and reactive power in electrical circuit, Construction, working principle, torque equation of single phase conventional (induction type) energy meter, Calibration of energy meter, block diagram and operation of digital Energy Meter.	[6]
<b>Unit 3: Measurement of Resistance, Inductance and Capacitance</b> Measurement of low, medium and high resistance, Wheatstone Bridge, Kelvin's Double Bridge, Ammeter-Voltmeter method, Megger, Earth tester for earth resistance measurement, inductance measurement: Maxwell's inductance Bridge, Maxwell's inductance capacitance bridge, Hay's Bridge, Anderson's Bridge, Schering Bridge and Wein's Bridge.	[8]
<b>Unit 4: Transducers</b> Transducers: Classification of transducers, general characteristics, Selection of transducers,	[6]



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Resistive, capacitive and inductive Transducers, Piezoelectric, Hall effect, optical and digital transducers, Elements of data acquisition system , Smart Sensors-Thermal Imagers.	
<b>Unit 5: Digital Meters</b> Digital instruments - pros and cons, working of digital voltmeters, Digital frequency meter, time interval measurement, digital LCR meter, digital multi-meters, Digital Tachometer, microprocessor-based instruments, Use of digital meters in Automization	[6]
<b>Unit 6: Storage and Display Devices</b> DSO, CRO, Power Analyzer, Wave Analyzer and Harmonic Distortion, Spectrum Analyzer, Instrument Transformers: Construction, connection of CT and PT in the circuit, advantages of CT / PT, LED and LCD display, Data Loggers.	[6]
<b>Textbooks:</b> 1. R K Rajput, Electrical and Electronic Measurement s and Instrumentation, S Chand Publishing, 2015. 2. Sawhney, A. K., A Course in Electrical and Electronic Measurement and Instrumentation, Dhanpat Rai and Sons, New Delhi.	
<b>Reference Books:</b> 1. H.S Kalsi , Electronic Instrumentation, TMH, 2010 2. U. A. Bakshi, A.V. Bakshi, K. A. Bakshi, Electrical Measurements, Technical Publications	



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### DC Machines and Transformers

23EE2303	PCC	DC Machines and Transformers	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Basic Electrical Engineering

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Explain the construction, types, and basic components of DC machines, special machines, and transformers.
CO2	Explain the working principles and characteristics of DC motors and transformers.
CO3	Determine emf in DC generators, torque and efficiency in DC motors, and voltage regulation in transformers.
CO4	Evaluate the performance, efficiency, and applications of DC machines, and transformers

**Course Contents:**

<b>Unit 1: DC Generators</b> Construction, Working, types, emf equation, armature reaction, Characteristics, Testing of DC Generators- O.C.C Test, Direct Load Test, applications, Numerical.	[6]
<b>Unit 2: DC Motors</b> Principles of working, Significance of back emf, Torque Equation, Types, Characteristics and Selection of DC Motors, Starting of DC Motors, Speed Control, Losses and Efficiency (Numerical), Braking of DC Motors, Testing of DC Motors- Brake Load, Swinburne's Test, Hopkinson's Test, Applications	[7]
<b>Unit 3: Special Machines</b> Construction, working principle, types and applications of stepper motors, Brushless DC motors, Permanent Magnet DC Motors, Servo motor.	[5]
<b>Unit 4: Single Phase Transformer</b> Transformer construction, Ideal and practical transformer, exact and approximate equivalent circuits, no load and on load operation, phasor diagrams, efficiency and voltage regulation (Numerical), parallel operation, effect of load on power factor, excitation phenomenon in transformers, Testing of single-phase transformers, Applications.	[6]
<b>Unit 5: Three Phase Transformers</b> Constructional features of three phase transformers, cooling methodology, transformer connections, Phase conversion, Parallel operation of three phase transformers, tap changing of transformers, Testing of Three phase transformers, Applications.	[6]
<b>Unit 6: Special Transformers</b> Auto transformers, Variable frequency transformer, voltage and current transformers, welding transformers, Pulse transformer, applications.	[6]



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**Textbooks:**

1. Bhattacharya S. K, Electrical Machines, Tata McGraw Hill Publications
2. Kothari Nagrath, Electrical Machines, Tata McGraw Hill Publications
3. M. N. Bandopadhyay, Electrical Machines, Tata McGraw Hill Publications

**Reference Books:**

1. Fitzerland, Electrical Machines, Tata McGraw Hill Publications
2. A.K.Sawhney, A Course in Electrical Machine Design, Dhanpat Rai and sons New Delhi
3. R. K. Agarwal, Principles of Electrical Machine Design, S. K. Katariya and sons.



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### Project Management

23EE2304	EEM	Project Management	2-0-0	2 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 2 hrs/week	CA1: 25 Marks CA2: 25 Marks

**Pre-Requisites:** --

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Define project management concepts and processes, including initiation, planning, execution, monitoring, controlling, and closure, using the PMBOK Guide.
CO2	Analyze project requirements and synthesize a comprehensive project scope statement and work breakdown structure (WBS) to ensure project deliverables align with stakeholder expectations.
CO3	Evaluate project schedules using Critical Path Method (CPM) and apply network diagramming techniques to identify critical paths and optimize project timelines.
CO4	Solve project costs using various estimation techniques and interpret Earned Value Management (EVM) metrics to track project performance and forecast budget deviations.
CO5	Assess project risks through identification, analysis, and prioritization, and develop risk response plans to mitigate potential threats and capitalize on opportunities.
CO6	Evaluate team dynamics and facilitate effective communication strategies, leadership techniques, and conflict resolution methods to foster collaboration and enhance project.

#### Course Contents:

<b>Unit 1: Introduction to Project Management</b> Overview of project management: definition, importance, and key concepts, Project life cycle: initiation, planning, execution, monitoring and controlling, closure, Project management processes and knowledge areas according to the PMBOK Guide.	[4]
<b>Unit 2: Project Planning and Scope Management</b> Project planning process: defining project objectives, scope, and deliverables, Work breakdown structure (WBS) development and decomposition techniques, Scope management: scope statement, scope verification, and scope control.	[4]
<b>Unit 3: Project Scheduling</b> Techniques for project scheduling: Gantt charts, network diagrams (PERT/CPM), Critical Path Method (CPM) and its applications in project scheduling,	[4]
<b>Unit 4: Project Time and Cost Management</b> Time management: estimating activity durations, scheduling constraints, and resource levelling, Cost estimation techniques: bottom-up estimation, analogous estimation, parametric estimation, Budgeting and cost control: budget development, cost monitoring, and cost performance analysis, Earned Value Management (EVM) and its use in project cost tracking and forecasting	[6]
<b>Unit 5: Project Risk Management</b> Risk identification, analysis, and assessment techniques, Risk response planning: risk mitigation, avoidance, transfer, and acceptance strategies, Risk monitoring and control:	[3]



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tracking identified risks, implementing risk responses, and updating risk management plans.	
<b>Unit 6: Project Team Management and Communication</b> Team formation and development: roles, responsibilities, and team dynamics, Effective communication strategies: communication planning, stakeholder engagement, and conflict resolution, Leadership and motivation: motivating team members, resolving conflicts, and fostering collaboration.	[3]
<b>Textbooks:</b> 1. Harold Kerzner, Project Management: A Systems Approach to Planning, Scheduling, and Controlling 2. Clifford F. Gray and Erik W. Larson, Project Management: The Managerial Process 3. Project Management Institute (PMI), A Guide to the Project Management Body of Knowledge (PMBOK Guide) 4. John M. Nicholas and Herman Steyn, Project Management for Engineering, Business, and Technology 5. Robert K. Wysocki, Effective Project Management: Traditional, Agile, Extreme	
<b>Reference Books:</b> 1. David I. Cleland and Lewis R. Ireland, Project Management: Strategic Design and Implementation 2. Eric Verzuh, The Fast Forward MBA in Project Management 3. Greg Horine, Project Management: Absolute Beginner's Guide 4. Harold Kerzner, Project Management Case Studies 5. Jeff Sutherland, Scrum: The Art of Doing Twice the Work in Half the Time	



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**Environmental Sciences**

23EE2305	MC	Environmental Sciences	2-0-0	Audit
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Teaching Scheme	Evaluation Scheme
Lecture: 2 hrs/week	CA1: 25 Marks CA2: 25 Marks

Pre-Requisites: Nil

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Explain various natural resources and associated Problems.
CO2	Summarize various ecosystems.
CO3	Explain the importance of conservation of biodiversity and its importance in balancing the earth.
CO4	Recognize various causes of environmental pollution along with various protection acts in India to limit the pollution.
CO5	Analyze field study data to extract relevant information and prepare a comprehensive report

**Course Contents:**

<p><b>Unit 1: Nature of Environmental Studies:</b>            Definition, scope and importance, Multidisciplinary nature of environmental studies. Need for public awareness.</p>	[2]
<p><b>Unit 2: Natural Resources and Associated Problems:</b>            a) Forest resources: Use and over-exploitation, deforestation, dams and their effects on forests and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dam's benefits and problems. c) Mineral resources: Usage and exploitation. Environmental effects of extracting and using mineral resources. d) Energy resources: Growing energy needs, renewable and non-renewable energy resources, use of alternate energy sources. Solar energy, Biomass energy, Nuclear energy. e) Land resources: Solar energy, Biomass energy, Nuclear energy, Land as a resource, land degradation, man induced landslides, soil erosion and desertification. f) Role of individuals in conservation of natural resources</p>	[6]
<p><b>Unit 3: Ecosystems:</b>            Concept of an eco-system. Structure and function of an ecosystem. Producers, consumers and de composers. Energy flow in the eco system. Ecological succession. Food chain etc. in concern with forest ecosystem, Producers, consumers and decomposers. Energy flow in the ecosystem. Ecological succession. Food chain etc. in concern with Grassland ecosystem, Producers, consumers and decomposers. Energy flow in the ecosystem. Ecological succession. Food chain etc. in concern with Desert ecosystem, Producers, consumers and decomposers. Energy flow in the ecosystem. Ecological succession. Food chain etc. in concern with various aquatic ecosystems</p>	[4]



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<b>Unit 4: Biodiversity:</b> Introduction- Definition: genetic, species and ecosystem diversity. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Various approaches for the conservation of biodiversity.	[4]
<b>Unit 5: Environmental Pollution and Environmental Protection:</b> Definition: Causes, effects and control measures of various types of pollution. Solid waste Management: Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution, Concept of sustainable development: From Unsustainable to Sustainable development, Various environmental Protection Acts and their scope.	[4]
<b>Unit 6: Field Work:</b> The student should Visit to a local area to document environmental Assets- River/Forest/Grassland/Hill/Mountain. Or Visit to a local polluted site - Urban / Rural / Industrial /Agricultural. Or Study of common plants, insects, birds or Study of simple ecosystems - ponds, river, hill slopes, etc. <b>The student should expect to do this activity in a group size of 4-5 and prepare and submit a report on it.</b>	[4]
<b>Textbooks/Reference Books:</b> 1. Agarwal, K.C., Environmental Biology, Nidi Pub. Ltd., Bikaner, 2001. 2. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., India, 3. Brunner R.C., Hazardous Waste Incineration, McGraw Hill Inc. 1989.	



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**Network Analysis Laboratory**

23EE2306	PCC	Network Analysis Laboratory	0-0-2	1 Credit
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Teaching Scheme	Evaluation Scheme
Practical: 2 hrs/week	CA1: 25 Marks CA2: 25 Marks

**Pre-Requisites:** Basic Electrical Engineering, Fundamentals of Electrical Circuits.

**Course Outcomes:** At the end of the course students will be able to

CO1	Solve the equivalent resistance between two points using both star-delta and delta-star conversion methods.
CO2	Solve complex electrical circuits by applying the fundamental theorems, leading to a deeper understanding of circuit behaviour and verify by successfully applying the theorems with theoretical results.
CO3	Analyze RL circuits and RC circuits supplied by DC voltage sources with initial values, understanding transient responses
CO4	Solve the complete set of parameters (z, y, ABCD, h) for a given two-port networks, the tie-set and cut-set matrices for oriented graphs, and identify the total number of possible trees in the graph.
CO5	Solve for the total resistance, inductance, or capacitance of an R-L-C series circuit with AC excitation using circuit analysis principles.

**Course Contents:**

**List of Experiments:**

Minimum 8 experiments should be performed from the following list.

1. Determination of equivalent resistance between two points using star-delta or delta-star conversion
2. Verification of Superposition theorem
3. Verification of Thevenin's Theorem
4. Verification of Reciprocity Theorem
5. Verification of Maximum Power Transfer Theorem
6. Transient analysis of RL circuit supplied by DC Voltage source (Initial values)
7. Transient analysis of RC circuit supplied by DC Voltage source (Initial values)
8. Determination of matrices (tieset and cutset matrices) and also number of possible trees for the oriented graph
9. Determination of z and y parameters of the two port networks
10. Determination of ABCD and h parameters of the two port networks
11. Determination of R or L or C of R-L-C series Circuits with AC excitation.



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**Textbooks:**

1. M.E. Van Valkenberg, Network Analysis, Prentice Hall of India, 3<sup>rd</sup> Edition, 2000.
2. Charles K Alexander and Mathew N O Sadiku, Fundamentals of Electric Circuits, TMH, 3<sup>rd</sup> Edition, 2009.
3. Ravish R Singh, Electrical Networks, TMH, New Delhi, 2009.

**Reference Books:**

1. Hayt, Kemmerly and Durbin, Engineering Circuit Analysis, TMH, 7<sup>th</sup> Edition, 2010.
2. J. David Irwin and R. Mark Nelms, Basic Engineering Circuit Analysis, John Wiley, 8<sup>th</sup> Edition, 2006.
3. Roy Choudhury, Networks and Systems, 2<sup>nd</sup> Ed., New Age Int. Publications, 2006.
4. Joseph A. Edminister, Mahmood Maqvi, Theory and Problems of Electric Circuits, Schaum's Outline Series.
5. Robert L Boylestad, Introductory Circuit Analysis, Pearson Publications.



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### Measurement and Instrumentation Laboratory

23EE2307	PCC	Measurement and Instrumentation Laboratory	0-0-2	1 Credit
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Teaching Scheme	Evaluation Scheme
Practical: 2 hrs/week	CA1: 15 Marks CA2: 15 Marks End Semester Exam: 20 Marks

**Pre-Requisites:** Basic Electrical Engineering

**Course Outcomes:** At the end of the course students will be able to

CO1	Identify the different power measurement techniques used in electrical circuits, including the two-wattmeter method for active power measurement and appropriate methods for reactive power measurement.
CO2	Evaluate the precision measurement techniques for resistance, inductance, and capacitance
CO3	Analyze the calibration and maintenance procedures of single-phase energy meters, ensuring accuracy and adherence to industry standards.
CO4	Demonstrate use of digital meters and power analyser for measuring different parameters

#### Course Contents:

##### List of Experiments:

Minimum 8 experiments should be performed from the following list.

1. Measurement of active power in three phase's circuit using two wattmeter methods.
2. Measurement of reactive power in three phase circuit.
3. Calibration single phase energy meter.
4. Measurement of low resistance using Kelvin double bridge and medium resistance using Wheatstone bridge.
5. Measurement of inductance by using ac bridges.
6. Measurement of capacitance by using Schering Bridge.
7. Measurement of Speed and displacement.
8. Measurement of Strain.
9. Electrical Parameters measurement using digital multimeters and LCR meter.
10. Measurement of Current, Voltage, pf, Active power, Reactive power by using power analyzer.



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**Textbooks:**

1. R K Rajput, Electrical and Electronic Measurements and Instrumentation, S Chand Publishing, 2015.
2. Sawhney, A. K., A Course in Electrical and Electronic Measurement and Instrumentation, Dhanpat Rai and Sons, New Delhi.

**Reference Books:**

1. H.S Kalsi , Electronic Instrumentation, TMH, 2010
2. U. A. Bakshi, A.V. Bakshi, K. A. Bakshi, Electrical Measurements, Technical Publications



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**DC Machines and Transformers Laboratory**

23EE2308	PCC	DC Machines and Transformers Laboratory	0-0-2	1 Credit
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Teaching Scheme	Evaluation Scheme
Practical: 2 hrs/week	CA1: 15 Marks CA2: 15 Marks End Semester Exam: 20 Marks

**Pre-Requisites:** Basic Electrical Engineering

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Determine the efficiency of DC machines through various tests including Brake load test, Swinburne's Test, Hopkinson's Test and direct load test.
CO2	Analyze the results effectively by performing O.C.C. of DC Shunt Generator.
CO3	Test the voltage and current relations in Scott connection, open delta connection, and transformers.
CO4	Analyze their findings in a report based on an industrial visit to a Transformer manufacturing unit.

**List of Experiments:** Minimum 8 experiments should be performed from the following list.

1. To determine efficiency by Brake load test on DC Shunt motor.
2. To determine the efficiency of DC Machine at any desired load by Swinburne's Test.
3. To determine the efficiency of the DC Machines by Hopkinson's Test.
4. To perform O.C.C. of DC Shunt Generator.
5. To determine efficiency by direct load test on DC Generator.
6. To determine efficiency by Sumpner's Test.
7. To Test voltage and or Current relation in i) Scott connection ii) open delta connection
8. To determine efficiency by direct load test on single phase transformer.
9. To demonstrate the parallel operation of 3 phase transformer.
10. Report based on Industrial visit to a Transformer manufacturing unit.

**Textbooks:**

1. Bhattacharya S. K, Electrical Machines, Tata McGraw Hill Publications
2. Kothari Nagrath, Electrical Machines, Tata McGraw Hill Publications
3. M. N. Bhandopadhyay, Electrical Machines, Tata McGraw Hill Publications

**Reference Books:**

1. Fitzerland, Electrical Machines, Tata McGraw Hill Publications
2. A.K.Sawhney, A Course in Electrical Machine Design, Dhanpat Rai and sons New Delhi
3. K.L. Narang, A Text Book of Electrical Engineering Drawings, Satya Prakashan, New Delhi.
4. A Shanmugasundaram, G. Gangadharan, R. Palani, Electrical Machine Design Data Book, 3<sup>rd</sup> Edition, Wiely Eastern Ltd., New Delhi.



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**Mini Project-II**

23EE2309	CEP	Mini Project-II	0-0-2	1 credit
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Teaching Scheme	Evaluation Scheme
Practical: 2 hrs/week	CA1: 25 Marks CA2: 25 Marks

**Pre-Requisites:** Mini Project

**Course Objective:** The project is a part of addressing societal and industrial needs. An ideathon is a brief, intense event where students can work on some of the most important problems that the world is facing today. Ideathon's are brainstorming events where people with diverse knowledge backgrounds, skill sets and interests get together to predetermine problems, and come up with substantive, innovative and comprehensive solutions. An ideathon's output might be ideas, a roadmap or an actionable plan. Teams leverage design thinking and cutting-edge techniques to brainstorm and collaborate on potential solutions within a given time frame.

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Identify problems based on societal /research needs
CO2	Apply Knowledge and interpersonal skills to solve societal problems in a group.
CO3	Draw the proper inferences from available results through theoretical/experimental/simulations.
CO4	Analyze the impact of solutions in societal and environmental context for sustainable development.
CO5	Demonstrate capabilities of self-learning in a group, which leads to lifelong learning.
CO6	Demonstrate project management principles during project work.

**Course Contents:**

<b>Week 1: Higher Education and Case Study Pedagogy</b> <ul style="list-style-type: none"><li>Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.</li><li>Allocation of mentor</li></ul>	[2]
<b>Week 2: Topic Selection</b> <ul style="list-style-type: none"><li>Briefly interact with students to provide hand-holding for topic selection.</li><li>Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor</li><li><b>Illustrative Examples : Any Industry or Societal Problem</b><ul style="list-style-type: none"><li>Finalization of Title.</li></ul></li></ul>	[2]
<b>Week 3: Case Study Design/Ideathon: Part 1</b> <ul style="list-style-type: none"><li>If needed, provide hand-holding to students for finalizing objectives.</li><li>Review the objectives of the case study groups.</li><li>Identify what can be quantified related to your topic and how.</li></ul>	[2]



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<ul style="list-style-type: none"><li>Decide objectives for your case study.</li><li>Continue reading especially recent work specific to your topic.</li></ul>	
<b>Week 4: Case Study Design/Ideathon: Part 2</b> <ul style="list-style-type: none"><li>Prepare a roadmap of your case study; identify what is to be measured on the field.</li><li>Ensure student groups have finalized the objectives.</li></ul>	[2]
<b>Week 5: Survey Design</b> <ul style="list-style-type: none"><li>Prepare a questionnaire and try it out with your group members as mock.</li><li>Decide sampling strategy.</li></ul>	[2]
<b>Week 6: Analysis Phase-1</b> <ul style="list-style-type: none"><li>Students in a group shall understand problem effectively, propose multiple solution.</li><li>The students have to work on different approaches and search for the different methodology to solve the problem in consultation with the project guide.</li></ul>	[2]
<b>Week 7 Analysis Phase-2</b> <ul style="list-style-type: none"><li>The students have to finalize the best methodology to solve the problem in consultation with the project guide.</li><li>25% Presentation has to be conducted by mentor/guide based on above activity.</li></ul>	[2]
<b>Week 8: Analysis-3</b> <ul style="list-style-type: none"><li>Identify appropriate data visualization tools for your case study.</li><li>Analyze the data</li></ul>	[2]
<b>Week 9: Analysis-4</b> <ul style="list-style-type: none"><li>Identify appropriate data visualization tools for your case study.</li><li>Analyze the data</li></ul>	[2]
<b>Week 10: Report writing Part:1</b> <ul style="list-style-type: none"><li>Prepare an outline of the report and start organizing the write-up for the first draft.</li><li>Prepare and submit the first draft of the report to the course coordinator.</li></ul>	[2]
<b>Week 11: Report writing Part:2</b> <ul style="list-style-type: none"><li>Make necessary corrections if any as per the suggestions of course coordinator.</li><li>Submit the final draft of the case study</li></ul>	[2]
<b>Week 12: Final Presentation</b> <ul style="list-style-type: none"><li>50% Presentation has to be conducted by mentor/guide based on above activity.</li></ul>	[2]



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### Multidisciplinary Minor-I: Electrical System Planning and Design

23EEMDA1	MDM	Electrical System Planning and Design	2-0-0	2 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 2 hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Basic Electrical Engineering

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Explain the fundamental principles and components of electrical systems, including generation, transmission, and distribution.
CO2	Analyze load characteristics and evaluate demand forecasting techniques to estimate electrical loads accurately.
CO3	Apply system analysis techniques to identify power flow, short-circuit, and stability issues, and synthesize optimization strategies for system design.
CO4	Design distribution systems, selecting components and construct operational strategies to ensure reliability and efficiency.
CO5	Evaluate protection systems, synthesize coordination schemes, and justify their application in ensuring system safety.
CO6	Assess sustainable design principles, integrate renewable energy solutions, and justify their implementation for environmentally conscious electrical systems.

**Course Contents:**

<p><b>Unit 1: Introduction to Electrical System Planning</b>            Overview of electrical system planning and design, Components of electrical systems: generation, transmission, distribution, Factors influencing system planning –load growth, Technological advancements, environmental considerations.</p>	[4]
<p><b>Unit 2: Load Estimation and Demand Forecasting</b>            Load characteristics and classification: peak load, average load, diversity factor, Methods of load estimation: analytical methods, statistical methods, demand forecasting techniques.</p>	[5]
<p><b>Unit 3: System Analysis and Optimization</b>            Basic principles of system analysis: power flow analysis, short-circuit analysis, stability analysis, Optimization techniques in system design: economic dispatch, optimal power flow, reliability-centered maintenance.</p>	[5]
<p><b>Unit 4: Distribution System Design and Operation</b>            Components of distribution systems: substations, feeders, transformers, switchgear, Design considerations for distribution systems: voltage regulation, power factor correction, reliability.</p>	[3]



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<b>Unit 5: Protection and Coordination in Electrical Systems</b> Fundamentals of protection systems: overcurrent protection, differential protection, distance protection, Coordination of protection devices: time-current coordination, zone-selective interlocking.	[3]
<b>Unit 6: Sustainable Design Principles in Electrical Systems</b> Principles of sustainable design: energy efficiency, renewable energy integration, environmental impact mitigation, Green building standards and certifications: LEED, BREEAM, Green Star.	[4]
<b>Text Books:</b> <ol style="list-style-type: none"><li>1. Alexandra von Meier, Electric Power Systems: A Conceptual Introduction, Wiley, 2006</li><li>2. Turan Gonen, Electric Power Distribution System Engineering, Mc-Graw Hill Book Company, CRC Press, 2015</li><li>3. J. Duncan Glover, Thomas Overbye, and Mulukutla S. Sarma, Power System Analysis and Design, Cengage Learning, 2012.</li><li>4. Neil Sclater, John E. Traister, Handbook of Electrical Design Details, Tata Mc-Graw Hill Companies, 2003</li><li>5. Ned Mohan, Electric Power Systems: A First Course, John Wiley and Sons, 2012.</li><li>6. Badri Ram and D.N. Vishwakarma, Power System Protection and Switchgear, Tata McGraw Hill Education, 2011.</li></ol>	
<b>Reference Books:</b> <ol style="list-style-type: none"><li>1. Albert Thumann; Harry Franz, Efficient Electrical Systems Design Handbook, River Publishers, 2009</li><li>2. B R Gupta, Power System Analysis And Design, S Chand Limited, 2008</li></ol>	



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**Multidisciplinary Minor-I: Introduction to PLC**

23EEMDB1	MDM	Introduction to PLC	2-0-0	2 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 2 hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** --

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Define the components and architecture of PLC systems, including CPUs, I/O modules, power supplies, and communication modules.
CO2	Develop basic ladder logic programs using fundamental programming instructions such as contacts, coils, timers, and counters.
CO3	Interpret digital and analog I/O modules, and classify their applications in interfacing with sensors and actuators.
CO4	Apply advanced ladder logic instructions, including arithmetic, comparison, and data manipulation operations, to enhance automation and control system functionality.
CO5	Develop human-machine interface (HMI) screens for process visualization and control using HMI software.
CO6	Identify common PLC hardware and software faults, and formulate strategies for fault finding and diagnostics.

**Course Contents:**

<b>Unit-1: Basics of PLC</b> Invention of PLC, Sustainability of PLC, Definition of PLC, Classifications of PLCs, Role of PLC in Process Automation, Features of a PLC, I/O Devices of PLC, PLC Programming Devices, PLC Selection Criteria, Major PLC Vendors and their Products, Top Five PLC Vendors	[3]
<b>Unit-2: Design and Operation of PLC</b> Architecture of PLC, Central Control Unit of PLC, Functional Modes of PLC, PLC Program Structure and Execution, Programming Devices for PLC, Selection of I/O Modules for PLC — Sourcing and Sinking	[3]
<b>Unit-3: PLC Programming Tools</b> Programming Languages, IEC 61131-3 Structuring Resources, Ladder Diagram, <b>Variables and Data Types, Register, Timer</b> - On Delay Timer, Off Delay Timer, Pulse Timer, <b>Counter</b> - Up Counter, Down Counter, Up-Down Counter, <b>Arithmetic Function</b> Addition (ADD), Subtraction (SUB), Division (DIV), Square Root (SQRT)	[6]
<b>Unit-4: Advanced PLC Functions</b> Data Handling Functions, MOVE (MV), BLOCK TRANSFER (BT), TABLE AND REGISTER MOVE, Matrix Functions, Analog Signal Handling, PID Control with PLC, Digital Bit Function, Shift Register Function, Sequence Function, Function Chart to IEC 60848	[6]



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<b>Unit-5: PLC Communication</b> Necessity for PLC Communication, Data Transmission Formats, Communication with Field Instruments, PLC Protocols <b>PLC Networking and Interfacing</b> Remote I/O Systems, Peer-to-Peer Networks, Host Computer Links, Access, Protocol, and Modulation, Functions of LANs, Network Transmission Interfaces.	[3]
<b>Unit-6: Selection and Commissioning of PLC</b> PLC Selection Criteria, Vendor Selection, PLC Commissioning, PLC Auxiliary Functions, Maintenance of PLC, Operational Safety of PLC. <b>Future of PLC</b> PLC-Based Automation, PLC and Programmable Automation Controller, Unified Human-Machine Interface, Plug and Play Solution, Wireless Link of PLC, Enterprise Resource Planning with PLC, Industrial Internet of Things and PLC.	[3]
<b>Textbooks / Reference Books:</b> <ol style="list-style-type: none"><li>1. Chanchal Dey, Sunit Kumar Sen, Industrial Automation Technologies, CRC Press, 2020</li><li>2. A.K. Gupta and S.K. Arora, Industrial Automation and Control: A Textbook, Laxmi Publications, 2013</li><li>3. Frank D. Petruzella, Programmable Logic Controllers, TMH</li><li>4. Frank Lamb, Industrial Automation: Hands-On, TMH Education, 2013</li><li>5. Stamatios Manesis, George Nikolakopoulos, Introduction to Industrial Automation, CRC Press, 2018</li></ol>	



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**Multidisciplinary Minor-I: Energy Storage Systems**

23EEMDC1	MDM	Energy Storage Systems	2-0-0	2 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 2 hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Fundamentals of Electrical Engineering

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Define the different types of energy storage technologies and their significance in modern energy management.
CO2	Analyze the characteristics and applications of various electrochemical energy storage technologies, such as batteries and fuel cells.
CO3	Analyze the principles of chemical energy storage, including hydrogen storage and conversion, production methods such as electrolysis, steam reforming, and biomass gasification, and storage technologies
CO4	Analyze and evaluate various chemical energy storage systems, including batteries and fuel cells, based on their electrochemical principles, performance metrics, and emerging technologies.
CO5	Explain the principles and applications of thermal energy storage systems, including sensible, latent, and thermochemical storage.
CO6	Evaluate the challenges and opportunities in integrating energy storage systems with renewable energy sources and grid networks, examining grid-scale projects through case studies and exploring future trends.

**Course Contents:**

<p><b>Unit 1: Introduction to Energy Storage Systems</b>            Overview of energy storage systems and their significance in energy management, Types of energy storage technologies: electrochemical, mechanical, chemical, and thermal storage, Comparison of energy storage systems based on capacity, efficiency, response time, and cost</p>	[4]
<p><b>Unit 2: Electrochemical Energy Storage</b>            Principles of electrochemical energy storage: batteries and fuel cells, Types of batteries: lead-acid, lithium-ion, flow batteries, and redox flow batteries, Characteristics, applications, and limitations of different battery technologies.</p>	[4]
<p><b>Unit 3: Mechanical Energy Storage</b>            Principles of chemical energy storage: hydrogen storage and conversion, Hydrogen production methods: electrolysis, steam reforming, and biomass gasification, Hydrogen storage technologies: compression, liquefaction, and solid-state storage.</p>	[4]
<p><b>Unit 4: Chemical Energy Storage</b>            Chemical Energy Storage Systems: electrochemical principles, battery technologies (lead-acid, lithium-ion, nickel-cadmium), fuel cells (PEM, SOFC), energy density, efficiency, cycle life, hydrogen storage methods, recent advancements, future trends.</p>	[4]



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<b>Unit 5: Thermal Energy Storage</b> Principles of thermal energy storage: sensible, latent, and thermochemical storage, Types of thermal energy storage systems: water tanks, phase change materials (PCMs), and molten salt storage, Applications of thermal energy storage in solar thermal power plants and district heating systems.	[4]
<b>Unit 6: Integration of Energy Storage Systems</b> Challenges and opportunities in the integration of energy storage systems with renewable energy sources and grid networks, Grid-scale energy storage projects: case studies and real-world examples, Future trends and emerging technologies in energy storage systems.	[4]
<b>Text/ Reference Books:</b> <ol style="list-style-type: none"><li>1. Michael Sterner, Ingo Stadler, Handbook of Energy Storage: Demand, Technologies, Integration, Springer, 2019</li><li>2. Kalaiselvam Sivakumar and Angelos A. Oikonomou, Thermal Energy Storage Technologies for Sustainability: Systems Design, Assessment, and Applications, Elsevier, 2014</li><li>3. Nihal Kularatna, Kosala Gunawardane, Energy Storage Devices for Renewable Energy-Based Systems: Rechargeable Batteries and Supercapacitors, Academic Press, 2021</li><li>4. Przemyslaw Komarnicki, Pio Lombardi , Zbigniew Styczynski, Electric Energy Storage Systems: Flexibility Options for Smart Grids, Springer, 2017.</li><li>5. Abdellatif M. Sadeq, Energy Storage Systems: A Comprehensive Guide, First Edition: September 2023.</li></ol>	



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**Aptitude Skills-I**  
**(Verbal Ability)**

23HSSM01	VEC	Aptitude Skills-I	1-0-0	1 Credit
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Teaching Scheme	Evaluation Scheme
Lecture: 1 hrs/week	CA1: 25 Marks CA2: 25 Marks

**Pre-Requisites:** Communication Skills

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Apply sentence formation rules to spot the error.
CO2	Solve the questions based on the types of tenses.
CO3	Solve the questions based on Direct/Indirect Speech and Passive/active voice and Substitution and Elimination.
CO4	Make use of Proverbs, Idioms and phrases in sentence construction and the vocabulary.

**Course Contents:**

<b>Unit 1: Speed Math Techniques</b> Structure and Types of Sentences, Conditional Sentences	[3]
<b>Unit 2: Number System</b> Present tense, Past tense, Future tense, Use of Tenses in Sentence forming	[3]
<b>Unit 3: Basic Aptitude</b> Direct and Indirect Speech, Active and Passive Voice, Use of Modal verbs in Sentence Forming, Substitution and Elimination	[3]
<b>Unit 4: Speed- Time- Distance</b> Speed, Time, and Distance, Trains, Boats, Streams, Races	[3]
<b>Textbooks :</b> 1. Raymond Murphy, Essential English Grammar with Answers, Murphy 2. R.S. Aggarwal , Objective General English, S Chand Publishing; Revised Edition	
<b>Reference Books:</b> 1. Rao and D,V,Prasada, Wren andamp; Martin High School English Grammar and Composition 2. Murphy, Intermediate English Grammar with Answers, Cambridge University Press, Second Edition.	



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**Language Skills- I**

23HSSM02	VEC	Language Skills- I	0-0-2	1 Credit
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Teaching Scheme	Evaluation Scheme
Practical: 2 hrs/week	CA1: 25 Marks CA2: 25 Marks

**Pre-Requisites: Basics of Programming**

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Develop flowchart and Algorithm to solve the given problem statements.
CO2	Develops programs using Data Types and Operators.
CO3	Make use of Decision Making and Looping Statements to develop conditional programs.
CO4	Make use of Arrays to develop programs in C language.

**Course Contents:**

**List of Experiments**

1. Explain basics of C such as Editing, Compiling, Error Checking, executing, testing and debugging of Programs and Design Algorithms and Flowcharts.
2. Explain basics of Variable, Data types and operators and develop programs on arithmetic Operators.
3. Develop programs on Conditional, logical and Bitwise Operators.
4. Develop programs on Sizeof () and typecasting operator.
5. Develop programs on increment and decrement operator.
6. Develop programs on simple if and if-else statement.
7. Develop programs on simple if-else ladder and Nested if-else.
8. Develop programs on Switch case statement.
9. Develop programs on For-loop and Nested For-loop.
10. Develop programs on while and do-while loop.
11. Develop programs on one dimensional array.
12. Develop programs on two dimensional array.
13. Develop programs on string handling functions.

**Textbooks :**

1. C Programming Absolute Beginner's Guide, Que Publishing, 3<sup>rd</sup> Edition
2. Ajay Mittal, Programming in C Practical Approach, Pearson Publication

**Reference Books:**

1. C: The Complete Reference, McGraw Hill Education, 4<sup>th</sup> Edition
2. C Programming in easy steps, In Easy Steps Limited, 5<sup>th</sup> Edition.



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## **Teaching and Evaluation Scheme for SY B. Tech**

**Department of Electrical Engineering**

**Semester: IV**





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**Department:** Electrical Engineering

**Rev:** Course Structure/01/NEP/2023-24

**Class:** S.Y. B. Tech.

**Semester:** IV

Course Code	Course Type	Course	Teaching Scheme				Evaluation Scheme					Credits
			L	T	P	Total Hrs.	CAI	CAII	MSE	ESE	Total	
23EE2401	PCC	AC Machines	3	-	-	3	10	10	30	50	100	3
23EE2402	PCC	Analog and Digital Electronics	2	-	-	2	10	10	30	50	100	2
23EE2403	PCC	Power Systems Analysis	3	-	-	3	10	10	30	50	100	3
23EE2404	PCC	AC Machines Laboratory	-	-	2	2	15	15	-	20	50	1
23EE2405	PCC	Analog and Digital Electronics Laboratory	-	-	2	2	15	15	-	20	50	1
23EE2406	PCC	Power Systems Analysis Laboratory	-	-	2	2	25	25	-	-	50	1
23EE2407	VSEC	Data Analytics using Spread Sheets	-	-	4	4	25	25	-	-	50	2
23EE2408	CEP	Mini Project-III	-	-	2	2	25	25	-	-	50	1
23MILEXX	AEC	Modern Indian Language	2	-	-	2	25	25	-	-	50	2
23EEMDXX	MDM	<b>Multidisciplinary Minor-II</b>	3	-	-	3	10	10	30	50	100	3
23OEEE22	OEC	Open Elective Course-II	3	-	-	3	10	10	30	50	100	3
23HSSM03.EE	VEC	Aptitude Skills-II	1	-	-	1	25	25	-	-	50	Audit
23HSSM04	VEC	Language Skills-II	-	-	2	2	25	25	-	-	50	1
<b>Total</b>			<b>17</b>	<b>-</b>	<b>14</b>	<b>31</b>	<b>230</b>	<b>230</b>	<b>150</b>	<b>290</b>	<b>900</b>	<b>23</b>

**Multi-Disciplinary Minor Course-II**

Electrical System Design <b>(Basket - A)</b>	Automation and IOT <b>(Basket - B)</b>	Renewable Energy Sources and Grid Integration <b>(Basket - C)</b>
Electrical Estimation and Costing (23EEMDA2)	SCADA and HMI (23EEMDB2)	Grid Integration of RES (23EEMDC2)

\*Open Elective course will be offered to students of other programs and will not be offered to students of the same program.



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### AC Machines

23EE2401	PCC	AC Machines	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Basic Electrical Engineering

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Demonstrate an understanding of the construction and principle of operation of three-phase induction motors, three-phase alternators and synchronous motors.
CO2	Determine the losses and efficiency of three-phase induction motors.
CO3	Explain the operation of different types of single-phase induction motors, such as split-phase and capacitor start/run motors.
CO4	Assess the characteristics and applications of special AC machines, such as single-phase synchronous motors and hysteresis motors, to understand their unique features and advantages in various industrial applications.

#### Course Contents:

<b>Unit 1: Three Phase Induction Motor.</b> Construction and types of 3 ph. Induction motors, torque equation, starting torque, running torque (numerical treatment), Factors affecting torque, condition of maximum torque, torque slip characteristics, speed control, necessity of starters and its types, Applications of 3 ph. Induction motors	[6]
<b>Unit 2: Losses and efficiency of 3 phase induction motor.</b> Losses and efficiency of 3 phase induction motor, power flow diagram with numerical treatment, Concept of operation of 3 phase induction motor as induction generator, Double cage induction motor along with its characteristics, cogging and crawling of 3 phase induction motor, Testing of Induction Motors, Circle diagram (Numerical)	[8]
<b>Unit 3: Single Phase Motors</b> Double field revolving theory, types of single-phase induction motor (Split phase, capacitor start/run, shaded pole motors),	[4]
<b>Unit 4: Three phase alternator</b> Construction, principle of operation of three phase alternator, EMF equation, Concept of synchronous reactance and synchronous impedance, armature reaction (at unity, lagging zero and leading zero power factor) , alternator on load (resistive, inductive and capacitive). Numerical on voltage regulation, Parallel operation of three phase alternators.	[6]



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<b>Unit 5: Synchronous Motor</b> Construction, types, principle of operation of synchronous motor, armature reaction, determination of synchronous reactance, Phasor Diagram of three phase synchronous motor at Unity, lagging and leading power factor, Effect of excitation on power factor and armature current, power angle characteristics, Applications of synchronous Motor.	[6]
<b>Unit 6: Special A.C. Machines</b> Single phase synchronous motors, Permanent magnet AC motors, AC servomotors, Repulsion Motors, Hysteresis Motors, Universal Motors.	[6]
<b>Textbooks:</b> 1. S. K. Bhattacharya, Electrical Machines, Tata Mc-Graw-Hill publication III edition 2. B. L. Theraja, Electrical Technology Vol.II, S. Chand Publications 3. I. J. Nagrath, D. P. Kothari, Electrical Machines, Tata Mc-Graw-Hill Publication, 4 <sup>th</sup> Edition.	
<b>Reference Books:</b> 1. A. E. Fitzgerald, Electric Machinery, Mc-Graw Hill Publications, 6 <sup>th</sup> Edition 2. P S Bhimbhra, Electrical Machinery, Khanna Publications 3. Ashfaq Hussain, Electrical Machines, Dhanpat Rai and Sons	



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### Analog and Digital Electronics

23EE2402	PCC	Analog and Digital Electronics	2-0-0	2 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 2 hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Basic Electronics Engineering

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Analyze the characteristics and applications of various types of semiconductor diodes, including PN junction, Zener, LED, Schottky, PIN, Tunnel, and Photodiodes, and their roles in circuits such as voltage doublers, clippers, and clampers.
CO2	Explain the principles of transistor biasing, different transistor configurations (CB, CE, CC), and their use as switches, along with the construction and operation principles of MOSFETs.
CO3	Evaluate the performance characteristics and gains of different transistor amplifier configurations (CE, CB, CC) and understand the classification of amplifiers based on biasing conditions, including Class A, Class B, and Class C amplifiers.
CO4	Apply Boolean algebra laws, De-Morgan's Theorem, and Karnaugh maps to simplify Boolean expressions, and design combinational logic circuits such as universal gates, binary adders, subtractors, comparators, decoders-encoders, multiplexers-demultiplexers, and parity generators.
CO5	Analyze the functioning of synchronous and asynchronous counters, and examine data transmission methods in shift registers, including Serial-In Serial-Out (SISO), Serial-In Parallel-Out (SIPO), Parallel-In Serial-Out (PISO), and Parallel-In Parallel-Out (PIPO).
CO6	Comprehend the operation of various types of latches and flip-flops, including SR, JK, D, and T flip-flops, and their applications in digital circuits for storing and transferring data.

**Course Contents:**

<b>Unit 1: Semiconductor Diode and its applications</b> Semiconductor physics, VI Characteristics of P-N junction diode, Types of diodes and its Applications: Zener diode, LED, Schottky diode, PIN diode, Tunnel diode and Photodiode, Diode Applications, Voltage doublers, Clippers, Clampers.	[3]
<b>Unit 2: Bipolar Junction Transistors</b> Transistor biasing, Biasing rules, Transistor configurations: CB, CE, CC, Transistor as a switch-DC Load line. MOSFET, construction and principle of operation.	[4]
<b>Unit 3: Transistor Amplifiers</b> Classification of amplifiers, Characteristics and Gains of Transistor amplifier	[5]



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configurations: CE, CB and CC Amplifiers, Amplifier coupling, Amplifier configurations based on biasing condition: Class A, Class B Class C,	
<b>Unit 4: Boolean Algebra and Combinational logic circuits</b> Boolean expressions, Axioms and Laws of Boolean Algebra, De-Morgans Theorem, Reducing Boolean expressions, Minimization of SOP and POS expressions, Karnaugh maps(Numerical) Combinational Logic circuits: Universal Gates, Binary adder-subtractor, comparators, decoders-encoders, Multiplexers-De-multiplexers, Parity generators	[5]
<b>Unit 5: Shift Registers and Counters</b> Counters: Synchronous and Asynchronous, Up/Down counters, Data transmission in Shift Registers: SISO, SIPO, PISO and PIPO.	[3]
<b>Unit 6: Latches and Flip Flops</b> The SR Latch, Gated Latches (Clocked Flip Flops), Edge Triggered Flip Flops, Types of Flip Flop: SR Flip Flop, JK Flip Flop, D- Flip Flop, T-Flip Flop.	[4]
<b>Textbooks:</b> 1. B L Theraja, Basic Electronics Solid State, S Chand Limited. 2. Robert L Boylestad, Electronic Devices and Circuit Theory, Prentice-Hall of India 3. A Anand Kumar, Fundamentals of Digital Circuits, Prentice Hall India Pvt. Limited.	
<b>Reference Books:</b> 1. M Morris Mano, Digital Design, Prentice Hall. 2. Charles L Alexander, Mathew N. O. Sadiku, Fundamentals of Electric Circuits, 6 <sup>th</sup> Edition, Tata Mc Graw Hill Publication	



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### Power System Analysis

23EE2403	PCC	Power System Analysis	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Fundamentals of Electrical Engineering, Basic Circuit Analysis

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Explain the typical layout and components of an electrical power system, including hydro, thermal, and nuclear power plants, with emphasis on the construction and function of each component.
CO2	Analyze the structure of electrical power systems, including factors associated with generating stations and concepts such as load curve, load duration curve, base load, and peak load.
CO3	Describe the ratings, features, and field of use of major electrical equipment in power stations, including alternators, transformers, circuit breakers, and protective relays.
CO4	Evaluate the mechanical design aspects of overhead lines, including components, supports, conductor spacing, sag calculation, and effects of ice and wind loading.
CO5	Analyze the resistance, inductance and capacitance of transmission lines.
CO6	Classify transmission lines based on length and voltage levels, and analyse the performance of short and medium transmission lines.

**Course Contents:**

<p><b>Unit 1: Electrical Power Generation</b></p> <p>Overview of Electrical power system, typical layout of an electrical power system, introduction to different sources of energy, construction and working of hydro power plant, thermal power plant, nuclear power plant with block diagram and function of each component.</p>	[5]
<p><b>Unit 2: Structure of Electrical Power Systems and Tariff</b></p> <p><b>Structure of Electrical Power Systems:</b> Structure of electrical power system, Different factors associated with generating stations such as Connected load, Maximum demand, Demand factor, Average load, Load factor, Diversity factor, Plant capacity factor, Reserve capacity, Plant use factor, Load curve, Load duration curve, Concept of base load and peak load stations.</p> <p><b>Tariff:</b> Introduction of Tariff, Tariff setting principles, desirable characteristics of tariff, various consumer categories and implemented tariff such as two part tariff, three part tariff(Numerical on two part and three part tariff), Time of day tariff for H.T and L.T</p>	[6]



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<p>industrial and commercial consumers, Introduction to Availability based tariff (ABT), kVAh tariff.</p>	
<p><b>Unit 3: Major Electrical Equipment's in Power Station and Underground Cables</b>  <b>Major Electrical Equipment's in Power Station:</b> Descriptive treatment of ratings of various equipment used in power station, Special features, field of use of equipment like alternators, necessity of exciters, various excitation systems such as dc excitation, ac excitation and static excitation systems, Power transformers, voltage regulators, bus-bars, current limiting reactors, circuit breakers, protective relays. Current transformers, potential transformers, Lightning arresters, Earthing switches, isolators, Carrier current equipment's (P.L.C.C), Control panels, battery rooms, metering and other control room equipment in generating station.  <b>Underground Cables:</b> Construction of Cables, Classification of cables, XLPE cables, Capacitance of single core and three core cable, Dielectric stresses in single core cable, Grading of cables, inter sheath grading, capacitance grading.</p>	[6]
<p><b>Unit 4: Mechanical Design of Overhead lines and Insulators</b>  <b>Mechanical Design of Overhead lines:</b> Main components of overhead lines, Various types of line supports, Conductor spacing, Length of span, Calculation of sag for equal and unequal supports and effect of ice and wind loading.  <b>Overhead Line Insulators:</b> Types of insulators, its construction and their applications such as Pin type, Suspension type, Strain type, Shackle type, bushing, String efficiency, (Numerical on string efficiency and up to four discs only), Methods of improving string efficiency.</p>	[6]
<p><b>Unit 5: Resistance, Inductance and Capacitance of Transmission Line</b>  Resistance of transmission line, Skin effect and proximity effect, Factors responsible for production of these effects.  Internal and external flux linkages of single conductor, Inductance of single phase two wire line, Necessity of transposition, Inductance of three phase line with symmetrical and unsymmetrical spacing with transposition, Concept of G.M.R and G.M.D, Inductance of bundled conductors.  Electric potential at single charged conductor, Potential at conductor in a group of charged conductors, Capacitance of single phase line, Capacitance of single phase line with effect of earth's surface on electric field, Concept of G.M.R and G.M.D for capacitance calculations, need of transposition for capacitance calculations, Capacitance of three phase line with symmetrical and unsymmetrical spacing with transposition. Capacitance of single circuit and double circuit three phase line with symmetrical and unsymmetrical spacing considering transposition (without considering earth effect).</p>	[8]
<p><b>Unit 6: Performance of Transmission Line</b>  Classification of lines based on length and voltage levels, Performance of short transmission lines with voltage current relationship and phasor diagram, Representation of medium lines as 'Nominal <math>\Pi</math>' and 'Nominal T' circuits using R,L and C parameters, Ferranti effect, Representation of 'T' and '<math>\Pi</math>' models of lines as two port networks,</p>	[5]



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Evaluation and estimation of generalized circuit constants (ABCD) for short and medium lines, Estimation of efficiency and regulation of short and medium lines.

**Textbooks:**

1. B.M. Weedy, B.J. Cory, N. Jenkins, and Janaka B. Ekanayake, Electric Power Systems, John Wiley and Sons Limited, 2012.
2. Sivanagaraju S, S Satya Narayana, Electric Power Transmission and Distribution, Pearson Education India, 2009.
3. D. P. Kothari and I. J. Nagrath, Power System Engineering, TMH, India, 2007.
4. Singh S. N, Electric Power Generation, Transmission, and Distribution, PHI Learning, 2008
5. D.P. Kothari and I.J. Nagrath, Modern Power System Analysis, TMH, 2011.

**Reference Books:**

1. C. L. Wadhwa, Electrical Power Systems, New Age International Pvt. Ltd.,
2. Hadi Saadat, Power System Analysis, McGraw-Hill, 2004
3. Colin Bayliss and Brian Hardy, Transmission and Distribution Electrical Engineering, Elsevier Science, 2012
4. Ned Mohan, Tore M. Undeland, and WP. Robbins, Electric Power Systems: A First Course, Wiley, 2012.



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### AC Machines Laboratory

23EE2404	PCC	AC Machines Laboratory	0-0-2	1 Credit
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Teaching Scheme	Evaluation Scheme
Practical: 2 hrs/week	CA1: 15 Marks CA2: 15 Marks End Semester Exam: 20 Marks

**Pre-Requisites:** Basic Electrical Engineering

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Demonstrate an understanding of the efficiency and speed regulation of 3-phase squirrel cage induction motors through hands-on direct loading method experiments.
CO2	Analyze the performance of 3-phase slip ring induction motors using direct loading method, and interpret the results using circle diagrams.
CO3	Determine the efficiency and speed regulation of 1-phase induction motors through direct loading method experiments.
CO4	Determine the efficiency of alternators using direct loading method, and analyse voltage regulation using different methods such as EMF and MMF and ZPF.

**List of Experiments:** Minimum 8 experiments should be performed from the following list.

1. Field visit to Machine manufacturing industry.
2. Determination of efficiency and speed regulation of 3 phase Squirrel cage induction motor by direct loading method.
3. Determination of efficiency and speed regulation of 3 phase slip ring induction motor by direct loading method.
4. Performance Analysis of 3 Phase SCIM by conducting No Load and Blocked Rotor Test (Circle Diagram).
5. Determination of efficiency and speed regulation of 1 phase induction motor by direct loading method.
6. Determination of efficiency of Alternator by direct loading method.
7. Determination of Voltage regulation of an alternator by EMF and MMF method.
8. Determination of Voltage regulation of an alternator by ZPF method.
9. Demonstrate Parallel operation of three phase alternator.
10. Determination of efficiency of synchronous motor by direct loading.

**Textbooks:**

1. S. K. Bhattacharya, Electrical Machines, Tata Mc-Graw Hill publication, 3<sup>rd</sup> Edition
2. B. L. Theraja, Electrical Technology Vol.II, S. Chand Publications
3. I. J. Nagrath, D. P. Kothari, Electrical Machines, Tata Mc-Graw Hill Publication



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**Reference Books:**

1. A. E. Fitzgerald, Electric Machinery, Mc-Graw Hill Publications, 6<sup>th</sup> Edition.
2. P S Bhimbhra, Electrical Machinery, Khanna Publications.
3. Ashfaq Hussain, Electrical Machines, Dhanpat Rai and Sons.



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**Analog and Digital Electronics Laboratory**

23EE2405	PCC	Analog and Digital Electronics Laboratory	0-0-2	1 Credit
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Teaching Scheme	Evaluation Scheme
Practical: 2 hrs/week	CA1: 15 Marks CA2: 15 Marks End Semester Exam: 20 Marks

**Pre-Requisites:** Analog and Digital Electronics, Circuit Analysis

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Analyse simple electronic circuits including resistors, capacitors, circuit symbols, CRO, and function generators, to construct and.
CO2	Analyze performance characteristics of various rectifier circuits, including half-wave and full-wave rectifiers with and without filters.
CO3	Implement and verify the functionality of logic gates and combinational circuits, including basic and universal gates, Boolean functions, adders, subtractors, code converters, multiplexers, demultiplexers, encoders, decoders, and counters, to use in digital systems.

**Course Contents:**

**List of Experiments:** Minimum 8 experiments should be performed from the following list.

1. Study of basic electronic components: colour coding of resistors, selection of capacitors, circuit symbols, CRO, Function generator.
2. Design half wave rectifier with and without filter diode.
3. Design full wave rectifier with and without filter using diode.
4. Determine Input and output characteristic of BJT in CE configuration.
5. Determine Input and output characteristic of BJT in CB configuration.
6. Design Darlington emitter follower circuit.
7. P-N junction diode forward and reverse bias characteristics.
8. Zener diode characteristics
9. Study and verification of Basic Gates (AND,OR and NOT)
10. Study and verification of Universal Gates (NAND and NOR)
11. Implementation of the given Boolean function using logic gates
12. Realization of Half Adder and Full Adder/ Half subtractor and Full subtractor using Basic gates
13. Design and implementation of 4 bit binary Adder/ Sub tractor and BCD adder
14. Design and implementation of Multiplexer and De-multiplexer using logic gates.
15. Design and implementation of encoder and decoder using logic gates.
16. Design and implementation of 3-bit synchronous up/down counter



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**Textbooks:**

1. B L Theraja, Basic Electronics Solid State, S Chand Limited.
2. Robert L Boylestad, Electronic Devices and Circuit Theory, Prentice-Hall of India
3. A Anand Kumar, Fundamentals of Digital Circuits, Prentice Hall India Pvt. Limited.

**Reference Books:**

1. M Morris Mano, Digital Design, Prentice Hall.
2. Charles L Alexander, Mathew N. O. Sadiku, Fundamentals of Electric Circuits, 6<sup>th</sup> Edition, Tata Mc Graw Hill Publication



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**Power System Analysis Laboratory**

23EE2406	PCC	Power System Analysis Laboratory	0-0-2	1 Credit
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Teaching Scheme	Evaluation Scheme
Practical: 2 hrs/week	CA1: 25 Marks CA2: 25 Marks

**Pre-Requisites:** Fundamentals of Electrical Circuits, Basic Electrical Engineering

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Explain characteristics of hydroelectric, thermal and nuclear power generation plants by comprehensively understanding their construction, working principles, and component functions.
CO2	Analyze the structure of electrical power systems, including load parameters, generating station factors, and tariff structures, enabling them to effectively integrate available generating stations into load duration curves and apply various tariff setting principles.
CO3	Estimate the performance characteristics of transmission lines.

**Course Contents:**

**List of Experiments:** Minimum 8 experiments should be performed from the following list.

**1: Visit to Power Plants - Field Trip to Hydro/Thermal/Nuclear Power Plant.**

Objective: Understand the layout, components, and functioning of different types of power plants through observation and interaction with plant personnel.

**2: Calculation of Load Parameters and Load Duration Curve.**

Objective: Calculate and analyze various load parameters such as connected load, maximum demand, load factor, and load duration curve from given data.

**3: Visit to Transmission Substation - Identification and Functionality of Major Equipment.**

Objective: Identify and describe the major electrical equipment used in a model power station setup, including alternators, transformers, circuit breakers, and control panels.

**4: Testing of Underground Cable Characteristics.**

Objective: Measure and analyze the characteristics of underground cables, including capacitance and dielectric stresses, using experimental setups.

**5: Sag Calculation and Mechanical Design of Overhead Lines.**

Objective: Calculate sag and design overhead lines considering various factors such as conductor spacing, span length, and environmental conditions.

**6: Testing of Overhead Lines**

Objective: evaluate the string efficiency of overhead line insulators.

**7: Measurement of Resistance and Inductance of Transmission Line.**

Objective: Measure the resistance and inductance of transmission lines.



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**8:** Measurement of Capacitance of Transmission Line.

Objective: Measure the capacitance of transmission lines.

**9:** Performance Analysis of Short Transmission Lines

Objective: Analyze the voltage-current relationship and phasor diagram of short transmission lines to determine efficiency and regulation.

**10:** Modeling and Analysis of Medium Transmission Lines.

Objective: Model medium transmission lines as 'Nominal  $\Pi$ ' and 'Nominal T' circuits and estimate efficiency and regulation using ABCD parameters.

**Textbooks:**

1. B.M. Weedy, B.J. Cory, N. Jenkins, and Janaka B. Ekanayake, Electric Power Systems, John Wiley and Sons Limited, 2012.
2. Sivanagaraju S, S Satya Narayana, Electric Power Transmission and Distribution, Pearson Education India, 2009.
3. D. P. Kothari and I. J. Nagrath, Power System Engineering, TMH, India, 2007.
4. Singh S. N, Electric Power Generation, Transmission, and Distribution, PHI Learning, 2008
5. D.P. Kothari and I.J. Nagrath, Modern Power System Analysis, TMH, 2011.

**Reference Books:**

1. C. L. Wadhwa, Electrical Power Systems, New Age International Pvt. Ltd.,
2. Hadi Saadat, Power System Analysis, McGraw-Hill, 2004
3. Colin Bayliss and Brian Hardy, Transmission and Distribution Electrical Engineering, Elsevier Science, 2012
4. Ned Mohan, Tore M. Undeland, and WP. Robbins, Electric Power Systems: A First Course, Wiley, 2012.



### Data Analytics using Spread Sheets

23EE2407	VSEC	Data Analytics using Spread Sheets	0-0-4	2 Credits
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Teaching Scheme	Evaluation Scheme
Practical: 4 hrs/week	CA1: 25 Marks CA2: 25 Marks

**Pre-Requisites:** Nil

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Utilize spread sheet software for data analysis, including visualization, statistical analysis, and regression modelling.
CO2	Demonstrate effective data cleaning and pre-processing abilities, ensuring data quality through handling missing values, removing duplicates, and correcting errors.
CO3	Apply advanced spread sheet functions and techniques, such as pivot tables, conditional formatting, and what-if analysis, to derive meaningful insights and create interactive dashboards from complex datasets.

#### Course Contents:

##### 1) Introduction to Data Analysis Tools:

Familiarize students with spreadsheet software (e.g., Microsoft Excel, Google Sheets). Basic operations: entering data, formatting, sorting, and filtering.

##### 2) Data Visualization Techniques:

Create various types of charts (e.g., bar charts, line graphs, pie charts) to represent data visually. Customize chart elements and styles.

##### 3) Statistical Analysis with Functions:

Use statistical functions (e.g., SUM, AVERAGE, COUNT, MAX, MIN) to analyze datasets. Calculate measures of central tendency and dispersion.

##### 4) Regression Analysis:

Perform linear regression analysis to explore the relationship between two variables. Plot a regression line on a scatter plot and interpret the results.

##### 5) Data Cleaning and Preprocessing:

Clean and preprocess a dataset by removing duplicates, handling missing values, and correcting errors. Use text functions to manipulate and clean textual data.

##### 6) Pivot Tables and Pivot Charts:

Create pivot tables to summarize and analyze large datasets. Generate pivot charts to visualize data trends and patterns.

##### 7) Conditional Formatting and Data Validation:

Apply conditional formatting rules to highlight specific data points based on predefined criteria. Implement data validation rules to ensure data accuracy and consistency.

##### 8) What-If Analysis:



Utilize scenario manager and goal seeks functionalities to perform what-if analysis. Evaluate the impact of changing input values on calculated results.

**9) Data Filtering and Advanced Sorting:**

Apply advanced filtering techniques (e.g., text, date, and custom filters) to extract specific subsets of data. Sort data based on multiple criteria and hierarchical levels.

**10) Importing External Data:**

Import data from external sources (e.g., text files, CSV files) into the spreadsheet. Explore options for data connectivity and integration.

**11) Data Analysis with Advanced Functions:**

Utilize advanced functions (e.g., VLOOKUP, HLOOKUP, INDEX, MATCH) to perform complex data analysis tasks. Combine functions to extract, manipulate, and analyze data efficiently.

**12) Dashboard Creation:**

Design a dashboard to present key insights and metrics derived from data analysis.

Incorporate interactive elements (e.g., slicers, dropdown lists) for user-friendly navigation.

**Textbooks/Reference Books:**

1. Kenneth N. Berk, Patrick Carey, Data Analysis with Microsoft Excel, Brooks/Cole, 2010.
2. Robert De Levie, Advanced Excel for Scientific Data Analysis, Oxford University Press, 2004.
3. Stephen L. Nelson, E. C. Nelson, Excel Data Analysis for Dummies, Wiley, 2015.
4. Ash Narayan Sah, Data Analysis Using Microsoft Excel, Excel Books, 2020.
5. Gordon S. Linoff, Data Analysis Using SQL and Excel, Wiley, 2010.
6. Manisha Nigam, Advanced Analytics with Excel 2019: Perform Data Analysis Using Excel's Most Popular Features, BPB Publications, 2020.



### Modern Indian Language

23MILE01	AEC	Marathi	2-0-0	2 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 2 hrs/week	CA1: 25 Marks CA2: 25 Marks

**Pre-Requisites:** Nil

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Develop the knowledge of local language/mother tongue and relate the same to daily life and social media.
CO2	Make use of rhetoric and verb to form sentences in Marathi Language.
CO3	Identify Infinitive compounds in the given Marathi sentence.
CO4	Make use of Phrases and proverbs and form a sentence and Solve Prose Assessment/ Summary Writing.
CO5	Model a letter to appropriate end user in Marathi Language.
CO6	Identify writing type of Marathi stanza and write appropriate writing.

**Course Contents:**

<b>अध्याय 01: भाषापरीचय</b> भाषा आणि व्यक्तिमत्त्वसहसंबंध, भाषा, जीवनव्यवहार आणि नवमाध्यमे व समाजमाध्यमे, चिन्हव्यवस्था- विरामचिन्हे, संवादकौशल्य (तोंडीपरीक्षा), सर्वनाम-पुरुषात्मक, दर्शक, संबंधी, प्रश्नार्थक, सामान्यव आत्मवाचक सर्वनाम, विशेषण-गुणविशेषण, संख्याविशेषण, सार्वनामीकविशेषण	[4]
<b>अध्याय 02: मराठी व्याकरण</b> नाम, सर्वनाम, विशेषणे, क्रियापद, क्रियाविशेषण अव्यय, शब्दयोगी अव्यय, उभयान्वयी अव्यय, केवलप्रयोगी अव्यय, विभक्तीवत्याचे प्रकार, काळव्यप्रकार	[4]
<b>अध्याय 03: अलंकारवक्रियापदे</b> <b>अलंकार-</b> शब्दालंकार- अनुप्रास, यमक, श्लेष उदाहरणे, अर्थालंकार-उपमा, उत्प्रेक्षा, व्यक्तिरेक, अपदुनती, रूपक, व्यक्तिरेक, अननव्य, अतिशयोक्ती उदाहरणे <b>प्रयोग-</b> कर्तरी, कर्मणी, भावे <b>वाक्यप्रकार-</b> केवलवाक्य, मिश्रवाक्य, संयुक्तवाक्य <b>समास-</b> अव्ययीभाव, तत्पुरुष, द्वंद्व, बहुवृही <b>क्रियापदे-</b> कर्तावकर्म, क्रियापदाचे प्रकार- अकर्मक, सकर्मक, उभयविध, संयुक्त, क्रियाविशेषण- कालवाचक, स्थळवाचक, रितीवाचक, संख्यावाचक, प्रश्नार्थक, निषेधार्थक	[4]
<b>अध्याय 04: वाक्यप्रचारवम्हणीवगद्य आकलन/सारांशलेखन</b> अर्थसांगून वाक्यात उपयोगकरणे (कमीतकमी ३० वाक्यप्रचारवम्हणी), गद्य आकलन - अपठित गद्य उतारावत्यावरील प्रश्न उत्तरे (कमीतकमी ०५ उतारेवत्यावरील प्रश्न उत्तरे), सारांश आकलन	[5]



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<b>अध्याय 05: लेखनप्रकार</b> पत्रलेखनवत्याचे प्रकार-निमंत्रण, आभार, अभिनंदन, मागणी, कोटुंबिक, विनंती, तक्रार संधी -स्वरसंधी, व्यंजनसंधी, विसर्गसंधी, वृत्तलेखन, जाहिरातलेखन, कथालेखन, अहवाललेखन, आवेदनपत्र, अभिप्रायलेखन	[5]
<b>अध्याय 06: कल्पनाविस्तारवमुलखात</b> कल्पनाविस्तार, मुलाखतकौशल्ये, मुलाखतीचे वैशिष्ट्ये, मुलाखतीचे स्वरूप, मुलाखतघेताना घ्यावयाची काळजी, मुलाखतघेताना आवश्यक बाबी उदा. आत्मविश्वास, व्यक्तिमत्वविकास, भाषाकौशल्येइ.	[4]
<b>Textbooks:</b> 1. व्यावहारिकमराठी, डॉ.ल.रा.नसिराबादकर, फडके प्रकाशन, कोल्हापूर. 2. व्यावहारिकमराठी, डॉ.लीलागोविलकर, डॉ.जयश्रीपाटणकर, स्नेहवर्धन प्रकाशन, पुणे 3. सुगममराठीव्याकरणलेखन, मो.रा. वाळंबे, नितीन प्रकाशन पुणे	
<b>Reference Books:</b> 1. अनिवार्यमराठीव्याकरण, लेखनवआकलन, डॉ. प्रल्हादलुलेकर, केदारकाळवणे, Pearson पब्लिकेशन्स 2. मराठीवइंग्रजी अत्यावश्यकनिबंध, प्रा.विजयकुमारवेधपाठक, K'Sagar पब्लिकेशन 3. उपयोजितलेखन, मराठी, प्राचीशेंडे, सावलीम्हात्रे, टारगेटपब्लिकेशन्स	



### Modern Indian Language

23MILE02	AEC	Hindi	2-0-0	2 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 2 hrs/week	CA1: 25 Marks CA2: 25 Marks

**Pre-Requisites:** Nil

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Develop the awareness of Hindi language and relate the same to daily life and social media.
CO2	Identify Infinitive compounds in the given Hindi sentence.
CO3	Make use of Phrases and proverbs and form a sentence in Hindi language.
CO4	Identify the mistakes in grammar of Hindi language and corrections in it
CO5	Make use of rhetoric to form sentences in Hindi Language
CO6	Illustrate the prose and verse in the given literature

**Course Contents:**

<b>अध्याय 01: हिंदीभाषापरीचय</b> हिन्दीभाषा और उसका विकास, हिन्दीसाहित्यका इतिहास, भाषाके विभिन्न मौखिक भाषा, लिखित भाषा, रूप-वर्णमाला, विरामचिन्ह, शब्दरचना, अर्थ, वाक्यरचना, वर्णोंका उच्चारण और वर्गीकरण	[5]
<b>अध्याय 02: समास</b> समास, क्रियाएँ, अनेकार्थीशब्द, विलोमशब्द, पर्यायवाचीशब्द,	[5]
<b>अध्याय 03: मुहावरे एवं लोकोक्ति</b> मुहावरे एवं लोकोक्ति, तत्सम एवं तद्भव, देशज, विदेशी, वर्तनी, अर्थबोध	[4]
<b>अध्याय 04: हिन्दीभाषामें प्रयोग होने वाली अशुद्धियाँ</b> हिन्दीभाषामें प्रयोग होने वाली अशुद्धियाँ, अनेक शब्दोंके लिए एक शब्द, रस	[5]
<b>अध्याय 05: अलंकार</b> अलंकार, छन्द, विशेषण और विशेष्य, भाषा-विज्ञान	[4]
<b>अध्याय 06: भाषा-विज्ञान</b> भाषा-विज्ञान, हिन्दीपद्य/गद्यरचनावरचनाकार, संज्ञासे अवयवतक, रिक्तस्थानोंकी पूर्ति, क्रमबद्धता.	[4]



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**Textbooks:**

1. हिंदीव्याकरण- पंकमताप्रसदगुरु, प्रकाशनसंस्था, नईदिल्ली
2. हिंदीसाहित्यिककाविद्व्यानिकइतिहास-डॉगणपतिचंद्रगुप्त, लोकभारतीप्रकाशन, नईदिल्ली.

**Reference Books:**

1. हिंदीभाषाशिक्षण - संपाहिंदीअध्ययनमंडल, सावित्रीबाईफुलेपुणेविश्विद्यालयपुणे, राजकमलप्रकाशन



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### Mini Project-III

23EE2308	CEP	Mini Project-III	0-0-2	1 Credit
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Teaching Scheme	Evaluation Scheme
Practical: 2 Hours/week	CA1: - 25 Marks CA2: -25 Marks

**Pre-Requisites:** Mini Project, Mini Project II

#### About Hackathon

The project is a part of addressing societal and industrial needs. Hackathon is one of the platforms where students will solve real world challenges. This Course focuses on the selection of methods/engineering tools/analytical techniques for problem solving.

Through this course, students will gain the understanding of engineering basics and ideas, gain practical experience, have the opportunity to display their skills and learn about teamwork, financial management, communication skills and responsibility

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Select the appropriate method for solving the problem.
CO2	Make use of various engineering techniques and tools to give a solution.
CO3	Justify the methods /tools used to develop the solution.
CO4	Design / simulate the model/ project work.
CO5	Describe the solution with help of a project report and presentation.
CO6	Conclude the outcomes of project.

#### Course Contents:

<b>Week 1: Survey Design-1</b> <ul style="list-style-type: none"> <li>Ensure case study group students have made necessary communication and done a preparatory visit.</li> <li>Watch the lecture on survey design and study the notes.</li> <li>Prepare a questionnaire and try it out with your group members as mock.</li> </ul>	[2]
<b>Week 2: Survey Design-2</b> <ul style="list-style-type: none"> <li>Review survey questionnaire prepared by case study groups.</li> <li>Decide sampling strategy.</li> <li>Prepare a detailed schedule for fieldwork</li> </ul>	[2]
<b>Week 3: Fieldwork</b> <ul style="list-style-type: none"> <li>Data Collection: Collect quantitative data (e.g., statistics, usage metrics) and qualitative data (e.g., user stories, testimonials).</li> <li>Use data collection tools like questionnaires, observation checklists, and digital analytics.</li> </ul>	[2]



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<ul style="list-style-type: none"><li>• Ensure data accuracy and reliability through proper sampling and recording methods.</li></ul>	
<b>Week 4: Trails and Experimentation-1</b> <ul style="list-style-type: none"><li>• Initial Setup and Configuration</li><li>• Concept Validation</li><li>• Feasibility Testing</li></ul>	[2]
<b>Week 5: Trails and Experimentation-2</b> <ul style="list-style-type: none"><li>• Prototyping</li><li>• Functionality Testing</li></ul>	[2]
<b>Week 6: Trails and Experimentation-3</b> <ul style="list-style-type: none"><li>• Bug Identification and Fixing</li><li>• Integration Testing</li><li>• Security Testing</li><li>• 75% Presentation has to be conducted by mentor/guide based on above activity.</li></ul>	[2]
<b>Week 7 : Results</b> <ul style="list-style-type: none"><li>• Coordinator has to check and verify below points in term of result:</li><li>• Functional Performance</li><li>• Accuracy and Precision</li><li>• Efficiency</li><li>• Safety</li></ul>	[2]
<b>Week 8: Validation</b> <ul style="list-style-type: none"><li>• Coordinator has to check and verify below points in term of validation:</li><li>• Testing and Verification</li><li>• Compliance with Standards</li></ul>	[2]
<b>Week 9: Integration Testing</b> <ul style="list-style-type: none"><li>• Validate that the hardware integrates seamlessly with other systems or components as intended</li><li>• Perform compatibility tests with software, other hardware, and network systems.</li></ul>	[2]
<b>Week 10: Documentation and Reporting</b> <ul style="list-style-type: none"><li>• Maintain comprehensive documentation of design, development, testing, and validation processes</li><li>• Provide detailed reports on test results, issues found, and corrective actions taken.</li></ul>	[2]
<b>Week 11: Final Presentation</b> <ul style="list-style-type: none"><li>• 100% Presentation has to be conducted by mentor/guide based on above activity.</li><li>• Prototype/Final Software solution is mandatory at the time of final presentation along with report</li></ul>	[2]
<b>Week 12: Exhibition</b> <ul style="list-style-type: none"><li>• Mini project exhibition will be schedule with interdepartmental evaluation.</li></ul>	[2]



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### Multidisciplinary Minor-II: Electrical Estimation and Costing

23EEMDA2	MDM	Electrical Estimation and Costing	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Electrical System Planning and Design

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Define the scope and importance of electrical estimation and costing using appropriate terminology.
CO2	Apply diverse factors and demand factors to calculate electrical load for various types of buildings.
CO3	Evaluate material quantities and labor costs for electrical projects using estimation techniques and software tools.
CO4	Estimate costs for electrical installations; including wiring, conduit, and fixtures, applying appropriate costing techniques.
CO5	Prepare project cost estimates, develop cost breakdown structures, and implement budgeting and cost control techniques.
CO6	Analyze real-world electrical projects, present findings, and discuss estimation and costing strategies, demonstrating their understanding through practical application.

**Course Contents:**

<b>Unit 1: Introduction to Electrical Estimation and Costing</b> Overview of Electrical Estimation and Costing, Importance and Scope in Electrical Engineering Projects, Basic Concepts and Terminologies, Types of Estimates: Preliminary, Detailed, and Final, Factors Influencing Electrical Estimation and Costing.	[6]
<b>Unit 2: Electrical Load Estimation</b> Understanding Electrical Load Characteristics, Methods for Estimating Electrical Load: Diversity Factor, Demand Factor, Load Calculation for Residential, Commercial, and Industrial Buildings, Case Studies and Practical Examples.	[6]
<b>Unit 3: Material and Labour Estimation</b> Identification and Selection of Electrical Materials, Estimation of Material Quantities, Pricing and Costing of Electrical Materials, Estimation of Labour Costs, Costing Techniques and Software Tools for Estimation	[6]
<b>Unit 4: Estimation of Electrical Installation</b> Understanding Electrical Installation Requirements, Methods for Estimating Installation Costs, Factors Affecting Installation Costs: Wiring, Conduit, Fixtures, etc., Estimation of Power Distribution Systems, Case Studies and Practical Exercises.	[6]
<b>Unit 5: Costing for Electrical Projects</b> Preparation of Project Cost Estimates, Cost Breakdown Structure, Budgeting and Cost Control Techniques, Tendering Process and Bid Preparation, Risk Management in Project	[6]



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Costing.	
<b>Unit 6: Case Studies and Project Work</b> Analysis of Real-World Electrical Projects, Review of Estimation and Costing Techniques, Project Work: Estimation and Costing of Electrical Installation, Presentation of Project Findings and Cost Analysis, Feedback and Discussion.	[6]
<b>Textbooks:</b> 1. Wayne J. Del Pico, Electrical Estimating Methods. 2. Paul Rosenberg, Electrical Estimating Pal: The Professional's Choice. 3. Michael Holt, Electrical Estimating Techniques. 4. Robert M. Callahan, Electrical Cost Estimating. 5. J.B. Gupta, Electrical Installation Estimating and Costing.	
<b>Reference Books:</b> 1. Steven J. Peterson and Frank R. Dagostino, Estimating in Building Construction. 2. Leonard P. Toenjes, Construction Cost Estimating: Process and Practices. 3. S.L. Uppal, Electrical Estimating and Costing. 4. Edward J. Tyler, Estimating Electrical Construction. 5. Mark C. Tyler, Practical Electrical Estimating.	



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**Multidisciplinary Minor-II: SCADA and HMI**

23EEMDB2	MDM	SCADA and HMI	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Introduction to PLC

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Define the key concepts of SCADA and HMI systems, summarize their evolution, and explain their significance in industrial automation.
CO2	Analyze SCADA hardware and software components, differentiate between various data acquisition devices, and classify communication protocols used in SCADA systems.
CO3	Design graphical user interfaces (GUIs) for HMI systems, integrate data visualization techniques, and create alarm management systems using HMI software tools.
CO4	Configure SCADA servers and clients, implement database integration for data management, and evaluate security measures for SCADA systems.
CO5	Analyze the role of SCADA in power generation, transmission, and distribution, apply fault detection techniques, and assess energy management strategies using SCADA systems.
CO6	Evaluate big data analytics for predictive maintenance, integration of SCADA with emerging technologies such as IoT, cyber security challenges and solutions in SCADA systems.

**Course Contents:**

<b>Unit 1: Introduction to SCADA and HMI Systems</b> Overview of SCADA and HMI Systems, Evolution and Importance in Industrial Automation, Basic Concepts and Components, SCADA Architecture and Communication Protocols, HMI Design Principles and User Interface	[6]
<b>Unit 2: SCADA System Architecture</b> Understanding SCADA Hardware and Software Components, Data Acquisition and Control Devices, PLC Integration with SCADA Systems, Remote Terminal Units (RTUs) and Communication Networks, Case Studies and Practical Examples.	[6]
<b>Unit 3: HMI Development and Programming</b> HMI Software Tools and Platforms, Designing Graphical User Interfaces (GUIs), Data Visualization and Trend Analysis, Alarm Management and Event Handling, Simulation and Testing Techniques	[6]
<b>Unit 4: SCADA System Configuration and Deployment</b> Configuration of SCADA Servers and Clients, Database Integration and Data Management, SCADA System Security and Access Control, Redundancy and Fault Tolerance, Site Preparation and Installation Guidelines.	[6]
<b>Unit 5: SCADA Applications in Electrical Systems</b> SCADA Applications in Power Generation, Transmission, and Distribution, Monitoring and Control of Electrical Grids, Fault Detection and Diagnosis, Energy Management and	[6]



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Optimization, Case Studies and Real-World Applications.	
<b>Unit 6: Advanced Topics and Emerging Trends</b> SCADA in Smart Grids and Renewable Energy Systems, Integration with Internet of Things (IoT) Technologies, Big Data Analytics and Predictive Maintenance, Cyber security Challenges and Solutions, Future Directions and Career Opportunities.	[6]
<b>Textbooks:</b> 1. Manish Jain, SCADA System: Application and Basics 2. Patrice Micouin, Human-Machine Interface (HMI) Design Principles for Industrial Applications 3. Stuart A. Boyer, SCADA: Supervisory Control and Data Acquisition 4. Alireza Mousavi, Introduction to SCADA Systems 5. Vijay K. Garg, HMI/SCADA Software Solutions	
<b>Reference Books:</b> 1. Robert Radvanovsky and Jacob Brodsky, SCADA: Industrial Control Systems Security 2. David Bailey and Edwin Wright, Practical SCADA for Industry 3. Mohinder S. Grewal, SCADA: Supervisory Control and Data Acquisition Systems 4. Sami M. Khuri, Human Machine Interface (HMI) Technologies in Industrial Applications 5. Gregory S. McMillan, SCADA and Me: A Book for Children and Management	



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**Multi-Disciplinary Minor –II: Grid Integration of RES**

23EEMDC2	MDM	Grid Integration of RES	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Energy Storage Systems

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Summarize the different types of renewable energy sources and their significance in the context of grid integration, using appropriate terminology.
CO2	Analyze grid codes and technical standards, apply interconnection protocols, and assess the impact of RES integration on grid stability using quantitative methods.
CO3	Design power electronic converters for RES integration, evaluate control strategies for grid interfacing, and synthesize simulation models for power electronics systems.
CO4	Demonstrate proficiency in modeling solar photovoltaic systems, implement maximum power point tracking (MPPT) techniques, and evaluate the performance of PV systems in grid-connected applications.
CO5	Analyze wind turbine models, design control strategies for wind energy integration, and assess the impact of wind integration on grid stability through experimental validation.
CO6	Critique energy storage systems for RES integration, propose solutions for demand response and smart grid integration, and formulate research proposals for addressing future challenges in grid integration.

**Course Contents:**

<b>Unit 1: Introduction to Renewable Energy Sources (RES) and Grid Integration</b> Overview of Renewable Energy Sources: Solar, Wind, Hydro, Biomass, etc., Importance and Benefits of RES Integration into the Grid, Challenges and Opportunities in Grid Integration Basic Concepts of Grid Operation and Control, Policy and Regulatory Framework for RES Integration	[6]
<b>Unit 2: Grid Connection Requirements for RES</b> Grid Code Compliance and Technical Standards, Interconnection Protocols and Grid Connection Procedures, Reactive Power Management and Voltage Control, Impact of RES Integration on Grid Stability and Reliability, Case Studies and Best Practices in Grid Connection.	[6]
<b>Unit 3: Power Electronics for RES Integration</b> Introduction to Power Electronic Converters: Inverters, Converters, Controllers, Role of Power Electronics in RES Integration: Power Quality, Frequency Control, Grid Interfacing Techniques: Grid-Forming and Grid-Following Control, Control Strategies for RES Converters: MPPT, Voltage Regulation, Simulation and Design of Power	[6]



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Electronics Systems	
<b>Unit 4: Grid Integration of Solar Photovoltaic Systems</b> Grid Connection Requirements for Solar PV Systems, PV System Modeling and Simulation, Maximum Power Point Tracking (MPPT) Techniques, Impact of PV Integration on Grid Stability and Operation, Case Studies and Practical Examples	[6]
<b>Unit 5: Grid Integration of Wind Energy Systems</b> Grid Connection Requirements for Wind Turbines, Wind Turbine Modeling and Control, Wind Farm Configuration and Control Strategies, Impact of Wind Integration on Grid Stability and Power Quality, Case Studies and Real-World Applications	[6]
<b>Unit 6: Advanced Topics in Grid Integration of RES</b> Energy Storage Systems for RES Integration, Demand Response and Smart Grid Technologies, Microgrid Integration of RES, Forecasting Techniques for RES Output, Future Trends and Research Directions in Grid Integration	[6]
<b>Textbooks:</b> <ol style="list-style-type: none"><li>1. Lawrence Jones, Grid Integration of Renewable Energy Sources</li><li>2. Lawrence E. Jones, Renewable Energy Integration: Practical Management of Variability, Uncertainty, and Flexibility in Power Grids</li><li>3. Hemant Singh Sikarwar, Power Electronics for Renewable and Distributed Energy Systems: A Sourcebook of Topologies, Control, and Integration</li><li>4. Parimita Mohanty, Solar Photovoltaic System Applications: A Guidebook for Off-Grid Electrification</li><li>5. Mohd. Hasan Ali, Wind Energy Systems: Solutions for Power Quality and Stabilization</li></ol>	
<b>Reference Books:</b> <ol style="list-style-type: none"><li>1. Ali Sayigh, Renewable Energy Systems: Advanced Conversion Technologies and Applications</li><li>2. Stuart Borlase, Smart Grids: Advanced Technologies and Solutions</li><li>3. Ningbo Wang, Grid Integration and Dynamic Impact of Wind Energy</li><li>4. Pengwei Du, Energy Storage for Smart Grids: Planning and Operation for Renewable and Variable Energy Resources</li><li>5. Nikos Hatziargyriou, Microgrids: Design, Operation, Control, and Protection</li></ol>	



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**Aptitude Skills-II**  
**(Numerical Ability)**

23HSSM03.EE	VEC	Aptitude Skills-I	1-0-0	Audit
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Teaching Scheme	Evaluation Scheme
Lecture: 1 hr/week	CA1: 25 Marks CA2: 25 Marks

**Pre-Requisites:** Communication Skills

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Make use of multiplications, squares, square roots, cubes and cube roots to solve aptitude problems.
CO2	Solve questions based on Number system.
CO3	Solve questions based on percentage, average, ratio, proportion, Speed, Time and Distance.
CO4	Solve questions based on Profit and Loss and mensuration.

**Course Contents:**

<b>Unit 1: Speed Math Techniques</b> Multiplication, Squares, Square roots, Cubes, Cube roots	[3]
<b>Unit 2: Number System</b> Types of Number System, Last Digit Method, BODMAS Calculation, HCF and LCM, Progressions	[3]
<b>Unit 3: Basic Aptitude</b> Percentage, Average, Ratio and Proportion, Fraction, Partnership <b>Speed- Time- Distance</b> Speed, Time, and Distance, Trains, Boats, Streams, Races	[3]
<b>Unit 4: Business Aptitude</b> Profit and Loss, Simple Interest, Compound Interest <b>Geometry and Venn Diagram</b> 2D and 3D Mensuration, Venn diagram	[3]
<b>Textbooks :</b> 1. Arun Shrama, Quantitative aptitude for CAT. 2. RS Aggarwal, A Modern Approach to Verbal and Non-Verbal Reasoning, S. Chand Publisher, 2016 3. RS Aggarwal, Quantitative Aptitude for Competitive Examinations, S. Chand Publisher, 2016.	



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**Reference Books:**

1. Rajesh Verma, Fast Track Objective Arithmetic Paperback, 2018
2. Arun Sharma, Teach Yourself Quantitative Aptitude.
3. Dinesh Khattar, The Pearson Guide to Quantitative Aptitude for Competitive Examination.



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### Language Skills-II

23HSSM04	VEC	Language Skills- II	0-0-2	1 Credit
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Teaching Scheme	Evaluation Scheme
Practical: 2 hrs/week	CA1: 25 Marks CA2: 25 Marks

**Pre-Requisites:** Communication Skills, Language Skills- I

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Develop programs using Functions.
CO2	Make use of Structures and Union to develop programs in C language
CO3	Make use of Pointers to develop programs in C language
CO4	Develop programs to perform various operations on files using File Handling.

#### Course Contents:

##### List of Experiments

1. Develop programs on using different built-in functions.
2. Develop programs on using function without argument and without return category.
3. Develop programs on using function with argument and without return category.
4. Develop programs on using function without argument and with return category.
5. Develop programs on using function with argument and with return category.
6. Develop programs using more than one user defined functions
7. Develop programs on recursion
8. Develop programs on Structure using various entities and size of structure
9. Develop programs on array of structure
10. Develop programs on structures and functions and compare structure and union.
11. Develop programs to display different data type of data and their addresses using pointer.
12. Develop programs on pointer to array, pointer to structure, pointer to functions and pointer expressions.
13. Develop program to read, write and append data from a file.

##### Textbooks:

1. C Programming Absolute Beginner's Guide, Que Publishing, 3<sup>rd</sup> Edition
2. Ajay Mittal, Programming in C Practical Approach, Pearson Publication

##### Reference Books:

1. C: The Complete Reference, McGraw Hill Education, 4<sup>th</sup> Edition
2. C Programming in easy steps, In Easy Steps Limited, 5<sup>th</sup> Edition.



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## **Teaching and Evaluation Scheme for TY B. Tech**

**Department of Electrical Engineering**  
**Semester: V**





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**Department:** Department of Electrical Engineering

**Rev:** Course Structure/00/2023-24

**Class:** T.Y. B. Tech

**Semester:** V

Course Code	Type of Course	Course	Teaching Scheme				Evaluation Scheme					Credits
			L	T	P	Total Hrs	CA1	CA2	MSE	ESE	Total	
23EE3501	PCC	Power Electronics	3	-	-	3	10	10	30	50	100	3
23EE3502	PCC	Power System Stability and Control	3	-	-	3	10	10	30	50	100	3
23EE3503	PCC	Electrical Machine Design	3	-	-	3	10	10	30	50	100	3
23EE3504	PEC	Program Elective Course- I	3	-	-	3	10	10	30	50	100	3
23EE3505	PCC	Power Electronics Laboratory	-	-	2	2	15	15	-	20	50	1
23EE3506	PCC	Industrial Automation Laboratory	-	-	2	2	15	15	-	20	50	1
23EE3507	PCC	Electrical Machine Design Laboratory	-	-	2	2	25	25	-	-	50	1
23EE3508	CEP	Mini Project-IV	-	-	2	2	25	25	-	-	50	Audit
23EEMDX3	MDM	<b>Multi-Disciplinary Minor-III</b>	3	-	-	3	10	10	30	50	100	3
23OEEE33	OEC	<b>Open Elective-III</b>	3	-	-	3	10	10	30	50	100	3
23HSSM05	VEC	Aptitude Skills-III	1	-	-	1	25	25	-	-	50	Audit
23HSSM06	VEC	Language Skills-III	-	-	2	2	25	25	-	-	50	Audit
23EE3509	CEP	Industrial Training	-	-	-	-	-	-	-	50	50	Audit
<b>Total</b>			<b>19</b>	<b>-</b>	<b>10</b>	<b>29</b>	<b>190</b>	<b>190</b>	<b>180</b>	<b>390</b>	<b>950</b>	<b>21</b>

**Multidisciplinary Minor -III**

Electrical System Design (Basket - A)	Automation and IOT (Basket - B)	Renewable Energy Sources and Grid Integration (Basket - C)
Lighting System Design(23EEMDA3)	Industrial Automation(23EEMDB3)	Smart Grid(23EEMDC3)

**Program Elective Course-I**

A	Energy Audit and Conservation
B	Industrial Safety
C	Signals and Systems
D	Optimization Techniques



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**Power Electronics**

23EE3501	PCC	Power Electronics	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Basic Electrical Engineering; Basic Electronics Engineering

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Analyze power semiconductor devices, including diodes, rectifiers, MOSFETs, BJTs, and IGBTs, emphasizing their characteristics, switching operations, and applications in power electronics.
CO2	Develop single-phase and three-phase controlled rectifier circuits for various load conditions.
CO3	Evaluate thyristor characteristics, their models, and operational mechanisms, including protection techniques such as di/dt and dv/dt, along with firing circuits and triggering methods like DIACs and UJTs.
CO4	Demonstrate the ability to analyze and operate DC-DC converters (choppers) and DC-AC converters (inverters), emphasizing bridge configurations, harmonic reduction, and current source inverters
CO5	Apply the principles of phase control and integral cycle control to single-phase and three-phase full-wave controllers for resistive and inductive loads.
CO6	Analyze cycloconverter operations, including single-phase, three-phase, and load-commutated configurations, with emphasis on output voltage equations and harmonic reduction techniques.

**Course Contents:**

<p><b>Unit 1: Power Semiconductor Devices</b>            Power Diodes: Introduction, Diode Characteristics, Reverse Recovery Characteristics, Power Diode Types, Silicon Carbide Diodes, Silicon Carbide Schottky Diodes, Freewheeling diodes, Freewheeling diodes with RL load.            Diode Rectifiers: Introduction, Diode Circuits with DC Source connected to R and RL load, Single-Phase Full-Wave Rectifiers with R load, Single-Phase Full-Wave Rectifier with RL Load.            Power Transistors: Introduction, Power MOSFETs – Steady-State Characteristics, Switching Characteristics Bipolar Junction Transistors – Steady-State Characteristics, Switching Characteristics, Switching Limits, IGBTs, MOSFET Gate Drive, BJT Base Drive, Isolation of Gate and Base Drives, Pulse transformers and Opto-couplers</p>	[6]
<p><b>Unit 2: Phase Controlled Rectifiers</b>            Controlled Rectifiers: Introduction, Single phase half-wave circuit with RL Load, Single phase half-wave circuit with RL Load and Freewheeling Diode, Single phase half-wave circuit with RLE Load, Single-Phase Full Converters with RLE Load, Single-Phase Dual</p>	[6]



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Converters, Principle of operation of Three- Phase dual Converters.	
<b>Unit 3: Thyristors</b> Thyristors: Introduction, Thyristor Characteristics, Two-Transistor Model of Thyristor, Thyristor Turn-On, Thyristor Turn-Off, A brief study on Thyristor Types, Series Operation of Thyristors, Parallel Operation of Thyristors, di/dtProtection, dv/dtProtection, DIACs, Thyristor Firing Circuits, Unijunction Transistor..	[6]
<b>Unit 4: Choppers and Inverters</b> DC-DC Converters: Introduction, the principle of a step-down and step-up chopper with RL load, performance parameters, DC-DC converter classification. DC-AC Converters: Introduction, the principle of operation single-phase bridge inverters, three-phase bridge inverters, voltage control of single-phase inverters, Harmonic reductions, Current source inverters.	[6]
<b>Unit 5: AC Voltage Controllers</b> Introduction, Principle of phase control and Integral cycle control, Single-Phase Full-Wave Controllers with Resistive Loads, Single- Phase Full-Wave Controllers with Inductive Loads, Three-Phase Full-Wave Controllers.	[6]
<b>Unit 6: Cycloconverters</b> Introduction; Basic Principle; Single to single-phase cycloconverters; Three-phase half-wave cycloconverters; Cycloconverters for three phase output; Output voltage equation; Output harmonics in cycloconverter; Comparison between cycloconverter and DC link Converter; Load Commutated cycloconverter	[6]
<b>Textbook:</b>  1. Mohammad H Rashid, Power Electronics: Circuits Devices and Applications, Pearson 4 <sup>th</sup> Edition, 2014.	
<b>Reference Books:</b>  1. P.S. Bimbhra, Power Electronics, Khanna Publishers, 5 <sup>th</sup> Edition, 2012 2. Ned Mohan et al, Power Electronics: Converters, Applications and Design, Wiley 3 <sup>rd</sup> Edition, 2014. 3. Daniel W Hart, Power Electronics, McGraw Hill 1 <sup>st</sup> Edition, 2011. 4. Philip T Krein, Elements of Power Electronics, Oxford Indian Edition, 2008.	



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**Power System Stability and Control**

23EE3502	PCC	Power System Stability and Control	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Power System Analysis, AC Machines

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Explain the fundamental concepts of power system stability, including rotor angle stability, voltage stability, and frequency stability.
CO2	Evaluate load flow methods, including Gauss-Seidel and Newton-Raphson techniques, to solve power flow equations and optimize system operations
CO3	Apply the principles of symmetrical components and sequence networks to calculate sequence impedances and construct power system models.
CO4	Examine fault analysis techniques for symmetrical and unsymmetrical faults using sequence voltages, bus impedance matrices, and general procedures.
CO5	Explain the concept of voltage stability and voltage collapse in power systems and voltage stability improvement techniques.
CO6	Analyze frequency stability under various conditions, incorporating inertia dynamics, governor response, AGC, and the impact of renewable energy.

**Course Contents:**

<b>Unit 1: Introduction to Power System Stability</b> Basic concepts and definitions, Types of Stability: Rotor Angle Stability, Voltage Stability, Frequency Stability, Classification: Steady State, Transient, and Dynamic Stability, Power angle curve, An elementary view of transient stability ,swing equation ,M and H constant, Equal Area Criterion and its applications, critical clearing angle, Rotor angle stability, Importance of Power System Stability, Factors Affecting Power System Stability.	[6]
<b>Unit 2: Power Flow Analysis</b> Bus classification, Bus admittance matrix, General form of power flow equations, Gauss-Seidel and Newton-Raphson methods, Comparison of load flow methods	[6]
<b>Unit 3: Symmetrical Components</b> Symmetrical components, Dr. Fortescue Theorem, Component synthesis, Component analysis, Sequence impedances and Sequence networks, Sequence impedances of transmission lines, transformers, and synchronous machines, Construction of sequence network of a power system.	[6]
<b>Unit 4: Symmetrical and Unsymmetrical Faults</b> Symmetrical Faults: Classification, Effect of faults, Balanced three phase fault, Short circuit capacity, Symmetric fault analysis using bus impedance matrix.	[8]



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Unsymmetrical Faults: Assumptions, Sequence voltages of generator, General procedure for analysis of various faults, Analysis of unsymmetrical faults.	
<b>Unit 5: Voltage Stability</b> Concept of Voltage Stability and Voltage Collapse, Classification of Voltage Stability: Short Term and Long Term Voltage Stability, Factors Affecting Voltage Stability, Voltage Stability Improvement Techniques.	[6]
<b>Unit 6: Frequency Stability</b> Concept of Frequency Stability, Inertia and Frequency Dynamics, Primary Frequency, Control: Governor Response, Secondary Frequency Control: Automatic Generation Control (AGC), Impact of Renewable Energy on Frequency Stability, Frequency Stability under Islanding Conditions.	[6]
<b>Textbooks:</b> 1. I.J. Nagrath and D.P. Kothari, Power System Analysis, TMH Publication 2. Hadi Saadat, Power System Analysis, TMH. 3. B.S.R. Murty, Power System Analysis, B.S. Publications.	
<b>Reference Books:</b> 1. Glover, Sharma, Overbye, Thompson, Power Systems Analysis and Design, 5 <sup>th</sup> Edition, Cengage Learning, 2012. 2. Stevenson W.D., Elements of Power System Analysis, TMH. 3. Prabha Kundur, Power System Stability and Control, McGraw Hill Professional, 2022.	



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### Electrical Machine Design

23EE3503	PCC	Electrical Machine Design	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** DC Machine and Transformers, AC Machines

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Analyze the ratio of iron loss to copper loss and its impact on efficiency.
CO2	Solve for no-load current, equivalent circuit parameters, and performance characteristics of transformers.
CO3	Determine the main dimensions, winding configurations, and stator slot design for efficiency improvement.
CO4	Analyze the operating characteristics of three-phase induction motors, including no-load current, magnetizing current, short-circuit current, and performance parameters obtained using the circle diagram, to evaluate static torque, maximum torque, output, power factor.
CO5	Determine diameter and length using output equations and analyze the effect of short circuit ratio on performance.
CO6	Analyze machine designs as per Indian Standards (IS) and international testing methodologies.

**Course Contents:**

<b>Unit 1: Constructional Details And Design of Transformers</b> Output equation, EMF per turn. Ratio of iron loss to copper loss, Relation between core area and weights of iron and copper, optimum designs, Core design. Design of windings.	[6]
<b>Unit 2: Performance Evaluation of Transformer</b> Calculation of no-load current. Equivalent circuit and performance characteristics. Temperature rise. Design of tank and radiators.	[6]
<b>Unit 3: Constructional Details And Design of Three Phase Induction Motors</b> Output equation. Specific electric and magnetic loadings. Efficiency and power Factor, main dimensions. Type of winding and connection .Turns per phase, shape of stator slots. Number of stator slots, design of stators.	[7]
<b>Unit 4: Operating Characteristics of Three Phase Induction Motors</b> No load current Magnetizing current, loss component short circuit current. Use of circle diagram to obtain performance figures. Calculation of static torque, maximum torque, maximum output, maximum power factor. Dispersion coefficient.	[7]
<b>Unit 5: Design of Synchronous Machines</b> Construction of water wheel and turbo alternators. Different parts and materials used for Synchronous machine, choice of electric and magnetic loadings, Output equation. Determination of diameter and length, effect of short circuit ratio on machine performance.	[7]



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<b>Unit 6: Computer Aided Design of Electrical Machines</b> Benefits of computer in machine design, methods of approach, optimization and computer aided design of induction motor and three phase transformer, Testing as per IS.	[6]
<b>Textbooks:</b> 1. A. K. Sawhney, A Course in Electrical Machine Design, Dhanpat Rai and Sons, Delhi. 2. V.N. Mittle and A. Mittle, Design of Electrical Machines, Standard Publications and Distributors, Delhi.	
<b>Reference Books:</b> 1. R. K. Agarwal, Principles of Electrical Machine Design, S. K. Kataria and Sons, Delhi. 2. S.K. Sen, Principles of Electrical Machine Design with Computer Programmes, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.	



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**Program Elective Course-I: Energy Audit and Conservation**

23EE3504A	PEC	Energy Audit and Conservation	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Engineering Physics, Basic Electrical Engineering

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Evaluate global environmental issues and international frameworks like UNFCC, Kyoto Protocol, and COP to assess sustainable development practices.
CO2	Apply energy audit approaches and benchmarking techniques to optimize energy usage and system efficiencies.
CO3	Assess the performance of boilers, pumps, cooling towers, and cogeneration systems to identify energy conservation opportunities.
CO4	Apply strategies for electrical load management, power factor improvement, and the use of energy-efficient technologies to enhance system performance.
CO5	Evaluate financial analysis techniques and performance contracts to support investment decisions and energy conservation initiatives.
CO6	Develop energy conservation projects through planning, implementation, monitoring, and evaluation based on industrial and commercial case studies.

**Course Contents:**

<b>Unit 1: Global Environmental Concerns:</b> Global Environmental Issues, United Nations Framework Convention on Climate, Change (UNFCC), Kyoto Protocol, Conference of Parties (COP), Clean Development, Mechanism (CDM), Prototype Carbon Fund (PCF), Sustainable Development.	[5]
<b>Unit 2: Energy Management and Audit:</b> Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments.	[6]
<b>Unit 3: Thermal and Mechanical Systems:</b> Boilers: Types, Combustion in boilers, Performances evaluation- Direct Method and Indirect Method of Boiler Efficiency, Energy conservation opportunities; Pumps and Pumping System: Types, Performance evaluation, Energy conservation opportunities; Cooling Tower: Types and performance evaluation, Energy saving opportunities; Cogeneration: Definition, Need, Application, Advantages, Classification, Saving potentials.	[8]
<b>Unit 4: Electrical Systems:</b> Electricity billing, Electrical load management and maximum demand control, Power factor improvement and its benefit, Selection and location of capacitors, Performance	[7]



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assessment of PF capacitors, Automatic power factor controllers, Energy efficient motors, Soft starters with energy saver, Variable speed drives, Energy efficient transformers, Electronic ballast, Occupancy sensors, Energy efficient lighting controls	
<b>Unit 5: Financial Management:</b> Investment-need, Appraisal and criteria, Financial analysis techniques-Simple payback period, Return on investment, Net present value, Internal rate of return, Cash flows, Risk and sensitivity analysis; Financing options, Energy performance contracts and role of ESCOs.	[6]
<b>Unit 6: Case Studies</b> Planning, Implementation and monitoring of energy conservation project, Case studies on various Industrial Sectors and Commercial Establishments.	[4]
<b>Textbooks:</b> 1. Anil Kumar, Om Prakash, Prashant Singh Chauhan, Samsher Gautam, Energy Management Conservation and Audits, CRC Press, 2020. 2. Charles M Gottschalk, Industrial Energy Conservation, John Willey and Sons. 3. Paul O Callaghan, Energy Management Handbook, Tata Mc Graw Hill. 4. S. Rao and B. Parulekar, Energy Technology, Khanna Publishers.	
<b>Reference Books:</b> 1. Wayne C. Turner, Energy Management Handbook, Fairmont Press, Incorporated, 2018.	



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**Program Elective Course-I: Industrial Safety**

23EE3504B	PEC	Industrial Safety	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Nil

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Demonstrate an understanding of electrical hazards, including the effects of electric shock, safe practices, and protection techniques such as earthing and earth leakage circuit breakers.
CO2	Apply fire prevention measures by identifying the causes of fire and utilizing various fire extinguishers and fire detection systems effectively.
CO3	Apply the principles of accident prevention to effectively minimize hazards and errors in various environments.
CO4	Develop the ability to administer first aid for various injuries and emergencies, such as electric shocks, chemical burns, suffocation, fractures, and heat strokes.
CO5	Identify the need, classification, and selection of PPE based on specific body parts and hazards in various work environments.
CO6	Apply tailored safety measures for industries such as automobile, cement, chemical, electronics, food, petroleum, and sugar to enhance workplace safety.

**Course Contents:**

<b>Unit 1: Electrical Hazards and Safety</b> Concept of Electric Shock, Effects of shock on human body, Safe limits of amperages, safe distance from electrical lines, Overload and Short circuit protection, concept and Types of Earthing (Pipe and Plate), Earth Leakage circuit Breaker, Protection against voltage fluctuations, Concept of static electricity, Concept of Step and Touch Potential.	[6]
<b>Unit 2: Fire Hazards</b> Causes of Fire and Remedial Measures, classification of fire and extinguishers, Statutory Provisions, fire prevention and protection systems, Fire Detection and Alarm Systems, Types of Fire Extinguishers-Soda Acid (Water Type) Extinguisher, Foam Extinguisher, CO <sub>2</sub> (Compressed gas) Extinguisher, Dry Chemical Powder (DCP) Extinguisher, Fire Hydrants	[6]



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<b>Unit 3: Principles of Accidents Prevention</b> Need For Safety, Reasons For Accident Prevention:- Humanitarian, Economic Or Costs, Social, Productivity, Etc. Definition: Incident, Accident, Injury, Dangerous Occurrences, Unsafe Acts, Unsafe Conditions, Hazards, Error, Oversight, Mistakes Etc. Principles Of Accident Prevention, Unsafe Conditions, Remedies And Responsibilities	[6]
<b>Unit 4: First Aid</b> Need of First aid, Injuries And First Aid at a Glance:- Electric Shock, Eye-Wounds, Chemical Burns of the Eyes, Suffocation, Heart Attack, Bleeding Nose, Bleeding Ear, Infection, Heat stroke etc. Fractures, Foreign Body in the Body Part, Dressing and Bandaging, Electrical Injuries, Artificial Respiration, Burns and Scalds	[6]
<b>Unit 5: Personal Protective Equipment's</b> Need, Selection and Classification of PPE according to the body part and hazards, Head and Hair Protection, Ear Protection, Face and Eye Protection, Hand and Arm Protection, Foot and Leg Protection, Body, Skin and Fall Protection, Training, Maintenance, Precaution and Care of PPE.	[6]
<b>Unit 6: Safety Measures in Industry</b> Safety Measures In :Automobile Industry, Cement Industry, Chemical Industry, Electronics Industry, Food Industry, Glass Industry, Paper Industry, Petroleum Refinery And LPG Bottling Plants, Plastics Industry, Sugar Industry	[6]
<b>Text/Reference Books:</b> <ol style="list-style-type: none"><li>1. Dr. K. U. Mistry, Fundamentals of Industrial Safety and Health, Siddharth Prakashan, Ahmedabad.</li><li>2. Ratan Raj Tatiya, Elements of Industrial Hazards, Health, Safety, Environment and Loss Prevention, CRC Press Publication.</li><li>3. John Cadick, Mary Capelli-Schellpfeffer, Dennis K. Neitzel, Al Winfield, Electrical Safety Handbook, Mc Graw Hill Publication.</li><li>4. R. Craig Schroll, Industrial Fire Protection Handbook, CRC Press Publication.</li></ol>	



### Program Elective Course-I: Signals and Systems

23EE3504C	PEC	Signals and Systems	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Engineering Mathematics-I and II, Network Analysis

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Classify continuous and discrete signals and systems based on characteristics such as linearity, time invariance, causality, stability, and dynamics.
CO2	Analyze the zero-state and zero-input responses, convolution operations, and graphical representation of convolution for continuous and discrete-time systems.
CO3	Analyze periodic and aperiodic signals in the frequency domain using Fourier series and Fourier transforms, emphasizing properties like duality and time reversal.
CO4	Solve differential equations and perform system analysis using Laplace transforms to determine transfer functions, poles, and zeroes.
CO5	Apply Nyquist Sampling Theorem and discrete-time Fourier transform to represent and analyze aperiodic sequences in the time and frequency domains.
CO6	Evaluate discrete time signals and systems using Z-transforms to determine transfer functions, poles, zeroes, and the behaviour of FIR and IIR systems.

**Course Contents:**

<b>Unit 1: Introduction to Signals and Systems</b> Continuous and Discrete - Introduction, standard signals, signal, representation, classification of signals, systems – representation, classification, Linear, Time invariant, causal, BIBO stable, Static, dynamic	[8]
<b>Unit 2: Time Domain Analysis of Continuous and Discrete Time Systems</b> Zero state and Zero input response, Impulse response, Convolution and its properties, Convolution integral, Properties of Convolution integral, Convolution sum, Properties of Convolution sum, graphical representation of convolution	[6]
<b>Unit 3: Fourier Domain Analysis of Continuous Time Signal</b> Trigonometric Fourier series, Compact Trigonometric Fourier series, Exponential form, Dirichlet Conditions, Frequency domain representation of periodic signals, Fourier Transform representation of aperiodic signals, Properties of CFT duality, time reversal, Convolution – time and frequency domain	[6]



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<b>Unit 4: Laplace Transform Analysis of Signals and System</b> Definition, Properties, Solution of differential equation. Transfer function, Poles and Zeroes, System analysis using Laplace Transform.	[6]
<b>Unit 5: Fourier Domain Analysis of Discrete Time Signal</b> Representation of CT signals using Samples, Nyquist Sampling Theorem, Discrete time Fourier Transform, Representation of aperiodic sequence, Properties of DTFT: time reversal, Linear Convolution – time and frequency domain, conjugate symmetry.	[6]
<b>Unit 6: Z- Transform Analysis of Discrete Time Signals and Systems</b> Definition, Properties, Solution of difference equation. Transfer function, Poles and Zeroes, System analysis using Z-Transform, FIR, IIR systems.	[6]
<b>Textbooks:</b> <ol style="list-style-type: none"><li>1. A.V. Oppenheim, A.S. Wilsky, S.H. Nawab, Signals and Systems, 2<sup>nd</sup> Edition, Pearson, 2015.</li><li>2. B. P. Lathi, Principles of Linear Systems and Signals, 2<sup>nd</sup> Edition, Oxford University Press, 2005.</li><li>3. A. Anand Kumar, Signals and Systems, 3<sup>rd</sup> Edition, PHI, 2013.</li></ol>	
<b>Reference Books:</b> <ol style="list-style-type: none"><li>1. M. J. Roberts, Signals and Systems, 3<sup>rd</sup> Edition, Tata McGraw Hill, 2011.</li><li>2. Simon Haykin, Barry Van Veen, Signals and Systems, 2<sup>nd</sup> Edition, Wiley Publications, 2007.</li></ol>	



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**Program Elective Course-I: Optimization Techniques**

23EE3504D	PCC	Optimization Techniques	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisite:** Engineering Mathematics-I and II

**Course Outcomes:** At the end of the course, the students will be able to:

CO1	Classify optimization problems based on design constraints, objective function characteristics, and design variable properties and also evaluate the physical structure, equations, and deterministic nature of these problems.
CO2	Utilize classical optimization techniques, including the methods of Lagrange multipliers and Kuhn–Tucker conditions, to solve multivariable problems and demonstrate the use of simplex algorithms and duality principles in linear programming.
CO3	Develop effective strategies using advanced linear programming techniques, such as decomposition principles, sensitivity analysis, and Karmarkar’s interior method and apply these strategies to solve transportation and quadratic programming challenges.
CO4	Construct optimization models employing nonlinear programming methods like dynamic programming, Pontryagin’s Maximum Principle, and heuristic algorithms such as Particle Swarm Optimization (PSO) and Ant Colony Optimization.

**Course Contents:**

<b>Unit-1: Introduction to Optimization</b> Introduction, Engineering Applications of Optimization, Statement of an Optimization Problem: Design, Design Constraints, Constraint Surface, Objective Function, Objective Function Surfaces, Classification of Optimization Problems: Classification Based on: the Existence of Constraints, the Nature of the Design Variables, the Physical Structure of the Problem, the Nature of the Equations Involved, the Permissible Values of the Design Variables, the Deterministic Nature of the Variables, the Separability of the Functions, the Number of Objective Functions, Optimization Techniques	[6]
<b>Unit-2: Classical Optimization Techniques</b> Introduction, Single-Variable Optimization, Multivariable Optimization with No Constraints: Semidefinite Case, Saddle Point, Multivariable Optimization with Equality Constraints: Solution by Direct Substitution, the Method of Constrained Variation, the Method of Lagrange Multipliers, Multivariable Optimization with Inequality Constraints: Kuhn–Tucker Conditions, Constraint Qualification	[6]
<b>Unit-3: Linear Programming-I</b> Introduction, Standard Form of a Linear Programming Problem, Geometry of Linear Programming Problems, Definitions and Theorems, Solution of a System of Linear Simultaneous Equations, Motivation of the Simplex Method, Simplex Algorithm: Identifying	[7]



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an Optimal Point, Improving a Nonoptimal Basic Feasible Solution, Two Phases of the Simplex Method	
<b>Unit-4: Linear Programming-II</b> Introduction, Duality in Linear Programming: Symmetric Primal–Dual Relations, General Primal–Dual Relations, Primal–Dual Relations When the Primal Is in Standard Form, Duality Theorems, Dual Simplex Method, Decomposition Principle; Transportation Problem, Karmarkar’s Interior Method: Statement of the Problem, Conversion of an LP Problem into the Required Form, Algorithm; Quadratic Programming	[7]
<b>Unit-5: Dynamic Programming</b> Introduction, Multistage Decision Processes: Definition and Examples, Representation of a Multistage Decision Process, Conversion of a Non serial System to a Serial System, Types of Multistage Decision Problems; Concept of Suboptimization and Principle of Optimality, Computational Procedure in Dynamic Programming, Example Illustrating the Calculus Method of Solution.	[6]
<b>Unit-6: Mathematical Optimization Techniques</b> Introduction, Quadratic Forms, Unconstrained Optimization, Constrained Optimization, Pontryagin’s Maximum Principle, Functional Analytic Optimization Technique: The Minimum Norm Theorem, Simulated Annealing Algorithm (SAA), Particle Swarm Optimization (PSO) Algorithm: Basic Fundamentals of PSO Algorithm, General PSO Algorithm, Ant Colony Optimization.	[7]
<b>Textbooks/Reference Books:</b> 1. Singiresu S. Rao, Engineering Optimization: Theory and Practice, 4 <sup>th</sup> Edition, John Wiley and Sons, Inc.2009. 2. Soliman Abdel-Hady Soliman, Abdel-Aal Hassan Mantawy, Modern Optimization Techniques with Applications in Electric Power Systems, Springer, 2012. 3. H.A. Taha, Operations Research: An Introduction, 5 <sup>th</sup> Edition, Macmillan, New York, 1992. 4. K. Deb, Optimization for Engineering Design Algorithms and Examples, Prentice-Hall of India Pvt. Ltd., New Delhi, 1995 5. G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 1990.	



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**Power Electronics Laboratory**

23EE3505	PCC	Power Electronics Laboratory	0-0-2	1 Credit
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Teaching Scheme	Evaluation Scheme
Practical: 2hr/week	CA1:15 Marks CA2: 15 Marks End Semester Exam: 20 Marks

**Pre-Requisites:** Basic Electrical Engineering

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Analyze the static characteristics of key semiconductor devices such as SCRs, MOSFETs, IGBTs, and TRIACs, emphasizing their operational principles and applications in power electronics.
CO2	Design control circuits, including SCR turn-on circuits, digital triggering circuits, and AC voltage controllers using TRIAC-DIAC combinations, tailored to various types of loads.
CO3	Apply techniques such as semi-converters, choppers, and PWM inverters to control the speed of DC motors, stepper motors, and universal motors

**Course Contents:**

**List of Experiments:** Minimum 8 experiments should be performed from the following list.

1. Static Characteristics of SCR.
2. Static Characteristics of MOSFET and IGBT.
3. Characteristic of TRIAC.
4. SCR turn on circuit using synchronized UJT relaxation oscillator.
5. SCR digital triggering circuit for a single phase controlled rectifier and ac voltage regulator.
6. Single phase controlled full wave rectifier with R load, R –L load, R-L-E load with and without freewheeling diode
7. AC voltage controller using TRIAC and DIAC combination connected to R and RL loads.
8. Speed control of DC motor using single semi converter.
9. Speed control of stepper motor.
10. Speed control of universal motor using ac voltage regulator.
11. Speed control of a separately excited D.C. Motor using an IGBT or MOSFET chopper.
12. Single phase MOSFET/IGBT based PWM inverter.
13. To conduct survey field visit to study applications of rectifier, inverter, chopper and ac voltage controller

**Textbooks/Reference Books:**

1. Mohammad H Rashid, Power Electronics: Circuits Devices and Applications, Pearson 4<sup>th</sup>Edition, 2014.
2. P.S. Bimbhra, Power Electronics, Khanna Publishers, 5<sup>th</sup>Edition, 2012
3. Ned Mohan et al, Power Electronics: Converters, Applications and Design, Wiley 3<sup>rd</sup>Edition, 2014
4. Daniel W Hart, Power Electronics, McGraw Hill 1<sup>st</sup>Edition, 2011



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**Industrial Automation Laboratory**

23EE3506	PCC	Industrial Automation Laboratory	0-0-2	1 Credit
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Teaching Scheme	Evaluation Scheme
Practical: 2hr/week	CA1: 15 Marks CA2: 15 Marks End Semester Exam: 20 Marks

**Pre-Requisites:** ---

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Analyze the architecture and functionalities of Distributed Control Systems (DCS), Programmable Logic Controllers (PLC), and interface modules (AI, AO, DI, DO) to understand their roles in industrial automation systems.
CO2	Develop ladder logic programs using logic gates, timers, counters
CO3	Develop real-time PLC-based control applications such as traffic light control, servo motor operation, automatic bottle filling, and water level control systems for efficient automation.

**Course Contents:**

**List of Experiments:** Minimum 8 experiments should be performed from the following list.

1. Study hardware and software platforms for DCS
2. Study of PLC
3. Study of PLC field device interface modules (AI,AO,DI,DO modules)
4. Programming Logic Gates in PLC
5. Study, understand and perform experiments on timers and counters using PLC
6. Traffic Light Control using PLC
7. Automatic water level control system using PLC
8. Direct On line(DOL) Starting of Induction Motor with/without latching
9. Servo motor control using PLC
10. Automatic Forward and Reverse Control
11. Automatic bottle filling machine using PLC

**Textbooks/ Reference Books:**

1. George Nikolakopoulos and Stamatios Manesis, Introduction to Industrial Automation, CRC Press, 1<sup>st</sup> Edition, 2020.
2. A.K. Gupta and S.K. Arora, Industrial Automation and Robotics: An Introduction, Mercury Learning and Information, 1<sup>st</sup> Edition, 2016.
3. Kaushik Kumar and B. Sridhar Babu, Industrial Automation and Robotics: Techniques and Applications, CRC Press, 1<sup>st</sup> Edition, 2023.



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4. Richard L. Shell, Handbook of Industrial Automation, CRC Press, 1<sup>st</sup> Edition, 2000.
5. R.G. Jamkar, Industrial Automation Using PLC, SCADA and DCS, Global Education Limited, 2<sup>nd</sup> Edition, 2018.



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**Electrical Machine Design Laboratory**

23EE3507	PCC	Electrical Machine Design Laboratory	0-0-2	1 Credit
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Teaching Scheme	Evaluation Scheme
Practical: 2hr/week	CA1: 25 Marks CA2: 25 Marks

**Pre-Requisites:** DC Machines and Transformers, AC Machines

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Design electrical components such as chokes, starters, transformers, and three-phase induction motors, along with detailed design reports and general assembly sheets.
CO2	Develop detailed drawing sheets for simplex lap winding, wave winding, and AC lap winding, utilizing computer-aided design software like AutoCAD.
CO3	Analyze the use of symbols in electrical engineering and their application in designing and assembling electrical systems and components.

**Course Contents:**

**List of Experiments:** Minimum 8 experiments should be performed from the following list.

1. Symbols used in Electrical Engineering
2. Design and assembly of Choke with design report.
3. Design and assembly of Starter with design report.
4. Design and layout of simplex lap winding
5. Design and layout of wave winding
6. Design and layout of ac lap winding
7. Design and assembly of transformer with design report.
8. Design and assembly of three phase induction Motor with design report
9. Complete any two drawings sheets with the help of CAD Software

**Textbooks:**

1. A. K. Sawhney, A Course in Electrical Machine Design, Dhanpat Rai and Sons, Delhi.
2. V.N. Mittle and A. Mittle, Design of Electrical Machines, Standard Publications and Distributors, Delhi.

**Reference Books:**

1. R. K. Agarwal, Principles of Electrical Machine Design, S. K. Kataria and Sons, Delhi.
2. S.K. Sen, Principles of Electrical Machine Design with Computer Programmes, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.



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### Mini Project-IV

23EE3508	CEP	Mini Project-IV	0-0-2	Audit
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Teaching Scheme	Evaluation Scheme
Practical: 2 hrs/week	CA1: 25 Marks CA2: 25 Marks

**Pre-Requisites:**

**About Hackathon**

The project is a part of addressing societal and industrial needs. Hackathon is one of the platforms where students will solve real world challenges. This Course focuses on the selection of methods/engineering tools/analytical techniques for problem solving.

Through this course, students will gain the understanding of engineering basics and ideas, gain practical experience, have the opportunity to display their skills and learn about teamwork, financial management, communication skills and responsibility

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Select the appropriate method for solving the problem
CO2	Make use of various engineering techniques and tools to give a solution
CO3	Justify the methods /tools used to develop the solution
CO4	Design / simulate the model/ project work
CO5	Describe the solution with help of a project report and presentation
CO6	Conclude the outcomes of project.

**Course Contents:**

<p><b>Week 1: Survey Design-1</b></p> <ul style="list-style-type: none"> <li>Ensure case study group students have made necessary communication and done a preparatory visit.</li> <li>Watch the lecture on survey design and study the notes.</li> <li>Prepare a questionnaire and try it out with your group members as mock.</li> </ul>	[2]
<p><b>Week 2: Survey Design-2</b></p> <ul style="list-style-type: none"> <li>Review survey questionnaire prepared by case study groups.</li> <li>Decide sampling strategy.</li> <li>Prepare a detailed schedule for fieldwork</li> </ul>	[2]
<p><b>Week 3: Fieldwork</b></p> <ul style="list-style-type: none"> <li>Data Collection: Collect quantitative data (e.g., statistics, usage metrics) and qualitative data (e.g., user stories, testimonials).</li> <li>Use data collection tools like questionnaires, observation checklists, and digital analytics.</li> <li>Ensure data accuracy and reliability through proper sampling and recording methods.</li> <li>25% Presentation has to be conducted by mentor/guide based on above activity.</li> </ul>	[2]



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<b>Week 4: Trails and Experimentation-1</b> <ul style="list-style-type: none"><li>• Initial Setup and Configuration</li><li>• Concept Validation</li><li>• Feasibility Testing</li></ul>	[2]
<b>Week 5: Trails and Experimentation-2</b> <ul style="list-style-type: none"><li>• Prototyping</li><li>• Functionality Testing</li></ul>	[2]
<b>Week 6: Trails and Experimentation-3</b> <ul style="list-style-type: none"><li>• Bug Identification and Fixing</li><li>• Integration Testing</li><li>• Security Testing</li><li>• 75% Presentation has to be conducted by mentor/guide based on above activity.</li></ul>	[2]
<b>Week 7: Results</b> <ul style="list-style-type: none"><li>• Coordinator has to check and verify below points in term of result:</li><li>• Functional Performance</li><li>• Accuracy and Precision</li><li>• Efficiency</li><li>• Safety</li></ul>	[2]
<b>Week 8: Validation</b> <ul style="list-style-type: none"><li>• Coordinator has to check and verify below points in term of validation:</li><li>• Testing and Verification</li><li>• Compliance with Standards</li><li>• 75% Presentation has to be conducted by mentor/guide based on above activity.</li></ul>	[2]
<b>Week 9: Integration Testing</b> <ul style="list-style-type: none"><li>• Validate that the hardware integrates seamlessly with other systems or components as intended</li><li>• Perform compatibility tests with software, other hardware, and network systems.</li></ul>	[2]
<b>Week 10: Documentation and Reporting</b> <ul style="list-style-type: none"><li>• Maintain comprehensive documentation of design, development, testing, and validation processes</li><li>• Provide detailed reports on test results, issues found, and corrective actions taken.</li></ul>	[2]
<b>Week 11: Final Presentation</b> <ul style="list-style-type: none"><li>• 100% Presentation has to be conducted by mentor/guide based on above activity.</li><li>• Prototype/Final Software solution is mandatory at the time of final presentation along with report</li></ul>	[2]
<b>Week 12: Exhibition</b> <ul style="list-style-type: none"><li>• Mini project exhibition will be schedule with interdepartmental evaluation.</li></ul>	[2]



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**Multidisciplinary Minor -III: Lighting System Design**

23EEMDA3	MDM	Lighting System Design	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Electrical System Planning and Design, Electrical Estimation and Costing

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Analyze the physics of light and colour, human vision response, photometric quantities, and mechanisms of light generation like incandescence and luminescence.
CO2	Compare various lighting technologies, including incandescent, fluorescent, LED, HID, and laser-based sources, in terms of efficiency, spectral characteristics, and lifetime.
CO3	Select appropriate light sources and luminaires for different applications.
CO4	Apply advanced lighting control systems, including dimmers, timers, motion sensors, and IoT-based protocols like DALI, KNX, and DMX, to enhance energy efficiency and integrate renewable energy sources such as solar lighting.
CO5	Evaluate energy efficiency metrics, eco-friendly lighting solutions, and sustainable practices by applying standards like ASHRAE, LEED, and IEC.
CO6	Apply lighting simulation tools and international standards to design real-world lighting systems.

**Course Contents:**

<b>Unit 1: Fundamentals of Lighting</b> Nature of Light: Physics of Light and Colour, Human Vision and Eye Response, Illuminance, Luminance, and Luminous Efficacy, Photometric Quantities: Lumens, Lux, Candela, Basics of Light Generation (Incandescence, Luminescence).	[6]
<b>Unit 2: Light Sources and Luminaires</b> Incandescent, Fluorescent, LED, HID, and Laser-Based Lighting, Luminous Efficiency and Spectral Characteristics of Light Sources, Luminaire Components and Optical Design, Comparison of Lighting Technologies in Terms of Efficiency and Lifetime, Case Studies on LED vs. Traditional Lighting.	[6]
<b>Unit 3: Lighting System Design Principles</b> Indoor vs. Outdoor Lighting Considerations, Residential, Commercial, and Industrial Lighting Design, Lumen Method and Point-by-Point Method for Illumination Calculation, Lighting for Specific Applications (Offices, Stadiums, Roads, Theaters), Role of Reflectors, Diffusers, and Refractors in Luminaires.	[6]
<b>Unit 4: Lighting Control System</b> Role of Lighting Controls in Energy Efficiency, Dimmers, Timers, Motion Sensors, and Daylight Sensors, Smart Lighting and IoT-Based Controls, Basics of DALI, KNX, and DMX Lighting Protocols, Integration of Renewable Energy (Solar Lighting).	[6]
<b>Unit 5: Energy Efficiency and Sustainability</b>	[6]



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Energy Codes and Standards (ASHRAE, IEC, BIS, LEED), Energy Audits and Lighting Efficiency Metrics, LED Retrofits and Cost-Benefit Analysis, Light Pollution and Eco-Friendly Lighting, Case Study: Sustainable Lighting Projects.	
<b>Unit 6: Lighting Simulation and Standards</b> Introduction to Lighting Simulation Software (DIALux, Relux, AGi32) , Interpretation of Photometric Data Files (IES, LDT) , International Lighting Standards and Guidelines (IESNA, CIE, EN 12464-1) , Safety and Regulatory Compliance in Lighting Design , Final Project: Lighting System Design for a Real-World Application.	[6]
<b>Text Books/Reference Books:</b> 1. Mark Karlen, Christina Spangler, James R. Benya, Lighting Design Basics, Wiley, 4 <sup>th</sup> Edition, 2024 2. Gary Gordon, Interior Lighting for Designers, Wiley, 5 <sup>th</sup> Edition, 2015. 3. David L. DiLaura, Kevin W. Houser, Richard Mistrick, Gary Steffy, The IES Lighting Handbook, Illuminating Engineering Society, 10 <sup>th</sup> Edition, 2011. 4. Mark Karlen, Christina Spangler, Lighting Design Basics, Wiley, 3 <sup>rd</sup> Edition, 2017.	



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**Multidisciplinary Minor -III: Industrial Automation**

23EEMDB3	MDM	Industrial Automation	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Introduction to PLC, SCADA and HMI

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Apply knowledge of industrial automation types, pyramid structure, and process control to assess manufacturing systems effectively.
CO2	Analyze the working principles and industrial applications of sensors and actuators, including pneumatic, hydraulic, and electric systems.
CO3	Develop programmable logic controller (PLC) systems using ladder logic, timers, counters, and communication interfaces for industrial automation.
CO4	Summarize industrial communication protocols and networks, such as Fieldbus, Ethernet, and wireless systems, to ensure cybersecurity and efficient communication.
CO5	Develop SCADA and HMI systems for effective data logging, alarm management, and remote monitoring of industrial operations.
CO6	Apply Industry 4.0 concepts, including IoT, AI, cloud computing, digital twin technology, and predictive maintenance, to enhance automation and implement smart manufacturing solutions.

**Course Contents:**

<b>Unit 1: Introduction to Industrial Automation</b> Definition and Need for Industrial Automation, Types of Automation: Fixed, programmable, and Flexible Automation , Advantages and Challenges in Industrial Automation, Industrial Automation Pyramid: Sensors, Controllers, and Actuators , Overview of Process Control and Manufacturing Automation	[6]
<b>Unit 2: Sensors and Actuators</b> Types of Industrial Sensors (Proximity, Temperature, Pressure, Optical, Ultrasonic), Working Principles and Applications of Sensors, Actuators: Pneumatic, Hydraulic, and Electric Actuators , Signal Conditioning and Data Acquisition , Industrial Applications of Sensor-Actuator Systems	[6]
<b>Unit 3: Programmable Logic Controllers</b> Introduction to PLCs: Architecture, Operation, and Types , Ladder Logic Programming and PLC Programming Languages (IEC 61131-3), Timers, Counters, Relays, and Data Handling in PLCs, PLC Communication Interfaces (RS232, RS485, Ethernet), PLC Applications in Industrial Automation	[6]
<b>Unit 4: Industrial Communication and Networks</b> Basics of Industrial Communication, Fieldbus Protocols: Profibus, Modbus, CAN,	[6]



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DeviceNet, Industrial Ethernet: PROFINET, EtherCAT, Ethernet/IP, Wireless Communication in Industrial Automation , Cybersecurity in Industrial Networks	
<b>Unit 5: SCADA and HMI Systems</b> Introduction to Supervisory Control and Data Acquisition (SCADA) , SCADA Components: RTUs, MTUs, HMIs , Human-Machine Interface (HMI) Design Principles Data Logging, Alarm Management, and Remote Monitoring, Case Study: SCADA Applications in Power Plants and Manufacturing	[6]
<b>Unit 6: Industry 4.0 and Smart Manufacturing</b> Introduction to Industry 4.0: IoT, AI, and Cloud Computing in Automation , Digital Twin Technology, Industrial Robotics and Collaborative Robots (Cobots), Predictive Maintenance using Machine Learning, Industrial Case Study: Smart Factory Implementation.	[6]
<b>Text/ Reference Books:</b> 1. George Nikolakopoulos and Stamatios Manesis, Introduction to Industrial Automation, CRC Press, 1 <sup>st</sup> Edition, 2020. 2. A.K. Gupta and S.K. Arora, Industrial Automation and Robotics: An Introduction, Mercury Learning and Information, 1 <sup>st</sup> Edition, 2016. 3. Kaushik Kumar and B. Sridhar Babu, Industrial Automation and Robotics: Techniques and Applications, CRC Press, 1 <sup>st</sup> Edition, 2023. 4. Richard L. Shell, Handbook of Industrial Automation, CRC Press, 1 <sup>st</sup> Edition, 2000. 5. R.G. Jamkar, Industrial Automation Using PLC, SCADA and DCS, Global Education Limited, 2 <sup>nd</sup> Edition, 2018.	



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**Multidisciplinary Minor -III: Smart Grid**

23EEMDC3	MDM	Smart Grid	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Energy Storage System, Grid Integration of RES

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Analyze the evolution, key features, and global implementations of smart grids to understand their role in reliability, efficiency, and sustainability.
CO2	Apply advanced metering infrastructure and demand response programs, including TOU and RTP mechanisms, to optimize consumer participation and energy management.
CO3	Take-part in renewable energy sources like solar and wind, along with energy storage technologies, to address challenges in smart grid implementation.
CO4	Apply communication architectures and IoT-based smart sensors using wireless technologies to enhance smart grid monitoring and operations.
CO5	Evaluate security threats, encryption mechanisms, and data analytics techniques for load forecasting, fault detection, and grid optimization.
CO6	Interpret smart grid standards, policies, and future trends to propose innovative solutions like V2G and transactive energy for smart grid modernization.

**Course Contents:**

<b>Unit 1: Introduction to Smart Grid</b> Definition and Evolution of Smart Grid, Traditional Grid vs. Smart Grid , Need for Smart Grids: Reliability, Efficiency, and Sustainability, Key Features and Components of Smart Grid , Case Studies of Smart Grid Implementation Worldwide	[4]
<b>Unit 2: Smart Metering and Demand Response</b> Advanced Metering Infrastructure (AMI) and Smart Meters , Demand-Side Management (DSM) and Demand Response Programs , Time-of-Use (TOU) and Real-Time Pricing (RTP) Mechanisms, Net Metering and Consumer Participation , Home Energy Management Systems (HEMS)	[5]
<b>Unit 3: Renewable Energy Integration and Energy Storage</b> Solar, Wind, and Biomass Integration into Smart Grid , Distributed Energy Resources (DERs) and Microgrids, Energy Storage Technologies: Battery Storage, Pumped Hydro, Supercapacitors, Grid-Tied vs. Off-Grid Systems , Challenges and Solutions in Renewable Energy Grid Integration	[5]
<b>Unit 4: Smart Grid Communication and IoT Applications</b> Communication Architectures for Smart Grid , IoT and Smart Sensors in Smart Grids , Wireless Technologies: Zigbee, LoRa, Wi-Fi, 5G, and LPWAN , SCADA for Smart Grid Monitoring , Cloud Computing and Edge Computing in Smart Grid	[3]
<b>Unit 5: Cybersecurity and Data Analytics in Smart Grid</b> Security Threats and Vulnerabilities in Smart Grids , Encryption and Authentication	[3]



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Mechanisms , Blockchain Applications in Smart Grid Security , AI and Machine Learning for Load Forecasting and Fault Detection , Big Data Analytics for Grid Optimization	
<b>Unit 6: Smart Grid Policies, Standards, and Future Trends</b> IEEE, NIST, and IEC Smart Grid Standards , Government Policies and Regulations on Smart Grids , Case Studies on Smart Cities and Grid Modernization , Future Trends: AI-Driven Grids, V2G (Vehicle-to-Grid), Transactive Energy, Smart Grid Business Models and Economic Aspects	[4]
<b>Textbooks / Reference Books:</b>  <ol style="list-style-type: none"><li>1. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Smart Grid: Technology and Applications, Wiley, 1<sup>st</sup>Edition, 2012.</li><li>2. Dr. Subir Sen, Mr. Rajesh Kumar, Dr. D.P. Kothari, Smart Grid: Fundamentals and Applications, New Age International (P) Ltd., Publishers, 1<sup>st</sup>Edition, 2019.</li><li>3. Sudip Misra, Samaresh Bera, Smart Grid Technology: A Cloud Computing and Data Management Approach, Cambridge University Press, 1<sup>st</sup>Edition, 2018.</li><li>4. Bharat Modi, Anu Prakash, Yogesh Kumar, Fundamentals of Smart Grid Technology, S.K. Kataria and Sons, 2015.</li><li>5. James A. Momoh, Smart Grid: Fundamentals of Design and Analysis, Wiley-IEEE Press, 1<sup>st</sup>Edition, 2012.</li><li>6. Ali Keyhani, Mohammad N. Marwali, Min Dai, Integration of Green and Renewable Energy in Electric Power Systems, 1<sup>st</sup> Edition, John Wiley and Sons, 2009.</li></ol>	



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**Aptitude Skills-III**  
**(Verbal Ability)**

23HSSM05	VEC	Aptitude Skills- III	1-0-0	Audit
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Teaching Scheme	Evaluation Scheme
Lecture: 1hr/week	CA1: 25 Marks CA2: 25 Marks

**Pre-Requisites:** Aptitude Skills-I and II

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Solve the questions on ordering of words and Parts of Speech
CO2	Organize contents of Business Communications such as CV, emails and letters.
CO3	Solve the questions based on jumbled paragraphs and reading comprehension.
CO4	Solve the questions on spotting error and sentence correction.
CO5	Summarize proceedings of any event or conference.
CO6	Discuss about current and critical issues during group discussion.

**Course Contents:**

<b>Unit 1</b>	Parts of Speech, Punctuation Word Family (Using the same word as different Parts of Speech)	<b>[2]</b>
<b>Unit 2</b>	Analogy, Letter Writing(Formal), E-Mail Writing, CV Writing	<b>[2]</b>
<b>Unit 3</b>	Reading Comprehension, Paragraph Jumbles	<b>[2]</b>
<b>Unit 4</b>	Spotting Errors(in different part sof sentence),Subject-Verb Agreement Sentence Correction, Sentence Completion	<b>[2]</b>
<b>Unit 5</b>	OneWordSubstitution,NarratingEvents/Reports,Summary/PrecisWriting	<b>[2]</b>
<b>Unit 6</b>	Dialogue writing Group Discussion, Interview Skills (Using formal notations and gestures etc.)	<b>[2]</b>

**Textbooks:**

1. Raymond Murphy, Essential English Grammar with Answers, Murphy
2. Objective General English by R.S.Aggarwal, S Chand Publishing; Revised edition.

**Reference Books:**

1. Rao and D, V,Prasada, Wren and amp; Martin High School English Grammar and Composition Book, S Chand Publishing, 2017
2. Murphy, Intermediate English Grammar with Answers, Cambridge University Press, Second edition



### Language Skills-III

23HSSM05	HMS06	Language Skills- III	0-0-2	Audit
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Teaching Scheme	Evaluation Scheme
Practical: 2hrs/week	CA1: 25 Marks CA2: 25 Marks

**Pre-Requisites:** Language Skills-I and II

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Develop a program to read input and return output.
CO2	Develop a program using data types, Strings and variables
CO3	Develop a program using Unary, Binary and Ternary operator
CO4	Develop a program using Conditional and Logical statements.

#### Course Contents:

<b>1. Write a Python program to print "Hello, World!"</b> <ul style="list-style-type: none"> <li>○ Objective: Understand basic syntax, indentation, and output.</li> </ul>	<b>[2]</b>
<b>2. Write a program to demonstrate the use of different types of comments in Python.</b> <ul style="list-style-type: none"> <li>○ Objective: Single-line and multi-line comments.</li> </ul>	<b>[2]</b>
<b>3. Write a Python program that declares different types of variables and displays their data types using the type() function.</b> <ul style="list-style-type: none"> <li>○ Objective: Variables, data types, and type identification.</li> </ul>	<b>[2]</b>
<b>4. Write a program to demonstrate type casting and type conversion between int, float, and string.</b> <ul style="list-style-type: none"> <li>○ Objective: Type conversion, casting functions.</li> </ul>	<b>[2]</b>
<b>5. Write a Python script to perform string operations such as slicing, concatenation, upper(), lower(), and len().</b> <ul style="list-style-type: none"> <li>○ Objective: String manipulation and built-in functions.</li> </ul>	<b>[2]</b>
<b>6. Write a program to demonstrate the use of all arithmetic, logical, and bitwise operators.</b> <ul style="list-style-type: none"> <li>○ Objective: Operator functionality.</li> </ul>	<b>[2]</b>
<b>7. Write a Python program to use membership and identity operators with examples.</b> <ul style="list-style-type: none"> <li>○ Objective: in, not in, is, is not.</li> </ul>	<b>[2]</b>
<b>8. Write a Python program using a ternary operator to find the larger of two numbers.</b> <ul style="list-style-type: none"> <li>○ Objective: Conditional (inline) expressions.</li> </ul>	<b>[2]</b>
<b>9. Write a program that takes user input for age and prints whether the person is a child, teenager, adult, or senior citizen using if-elif-else.</b> <ul style="list-style-type: none"> <li>○ Objective: Conditional statements and user input.</li> </ul>	<b>[2]</b>



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10. <b>Write a program to find the sum of the first 10 natural numbers using a while loop.</b> ○ Objective: Looping with while.	[2]
11. <b>Write a Python script to display the multiplication table of a number using a for loop.</b> ○ Objective: Looping with for and range().	[2]
12. <b>Write a program that uses break, continue, and pass statements in appropriate looping scenarios.</b> ○ Objective: Loop control statements.	[2]
<b>Textbooks:</b> 1. Python Projects, Laura Cassell, Alan Gauld, Wrox publication 2. Murach's Python Programming, Michael Urban, Joel Murach, Murach's Publication.	
<b>Reference Books:</b> 1. Fundamentals of Python (First Program), K.A. Kambert, Cengage MINDTAP Publication 2 <sup>nd</sup> Edition.	



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**Industrial Training**

23EE3509	CEP	Industrial Training	0-0-0	Audit
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Teaching Scheme	Evaluation Scheme
Lecture: NA	End Semester Exam: 50 Marks

**Course Outcomes:** Students will be able to

CO1	Examine actual working environment
CO2	Demonstrate the use, interpretation and application of an appropriate engineering standard in a specific situation.
CO3	Identify sources of hazards, and assess/identify appropriate health & safety measures.
CO4	Summarize technical documents and give presentations related to the work completed

**Instruction:**

Students are expected to undergo industrial training for at least four weeks after IV semester. Training session shall be guided and certified by qualified engineer / industry expert. Students should prepare detailed report on activities carried out during training. Evaluation shall be based on report and power point presentation.



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## **Teaching and Evaluation Scheme for TY B. Tech**

**Department of Electrical Engineering**  
**Semester: VI**





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**Department:** Department of Electrical Engineering

**Rev:** Course Structure/00/2023-24

**Class:** T.Y. B. Tech

**Semester:** VI

Course Code	Type of Course	Course	Teaching Scheme				Evaluation Scheme					Credits
			L	T	P	Total Hrs	CA1	CA2	MSE	ESE	Total	
23EE3601	PCC	Electric Drives	3	-	-	3	10	10	30	50	100	3
23EE3602	PCC	Control Systems	3	-	-	3	10	10	30	50	100	3
23EE3603	PCC	Microcontrollers and Applications	3	-	-	3	10	10	30	50	100	3
23EE3604	PEC	Program Elective Course-II	3	-	-	3	10	10	30	50	100	3
23EE3605	VSEC	Financial Literacy	2	-	-	2	25	25	-	-	50	2
23EE3606	PCC	Electric Drives Laboratory	-	-	2	2	15	15		20	50	1
23EE3607	PCC	Control Systems Laboratory	-	-	2	2	25	25	-	-	50	1
23EE3608	PCC	Microcontrollers and Applications Laboratory	-	-	2	2	15	15	-	20	50	1
23EE3609	PROJ	Mega Project Phase –I	-	-	4	4	25	25	-	50	100	2
23EEMDX4	MDM	<b>Multidisciplinary Minor-IV</b>	3	-		3	10	10	30	50	100	3
23HSSM07	VEC	Aptitude Skills-IV	1	-		1	25	25	-	-	50	<b>Audit</b>
23HSSM08	VEC	Language Skills-IV	-	-	2	2	25	25	-	-	50	<b>Audit</b>
<b>Total</b>			<b>18</b>	<b>-</b>	<b>12</b>	<b>30</b>	<b>205</b>	<b>205</b>	<b>150</b>	<b>340</b>	<b>900</b>	<b>22</b>

**Multidisciplinary Minor -IV**

Electrical System Design (Basket - A)	Automation and IOT (Basket - B)	Renewable Energy Sources and Grid Integration (Basket - C)
Industrial System Design(23EEMDA4)	Introduction to Internet of Things (23EEMDB4)	Operation and Planning of Power System (23EEMDC4)

**Program Elective Course-II**

A	Utilization of Electrical Energy
B	Special Electrical Machines
C	Linear Integrated Circuits
D	E-Mobility



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### Electrical Drives

23EE3601	PCC	Electrical Drives	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Power Electronics

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Analyze the selection criteria, speed-torque characteristics, and operational modes of electric drives, focusing on steady-state stability and closed-loop speed control.
CO2	Apply speed control, starting, braking, and multi-quadrant operations for DC drives using converters and choppers in various configurations.
CO3	Design speed control methods and VSI/CSI-fed induction motor drives while evaluating torque characteristics and closed-loop speed control systems.
CO4	Apply slip power recovery methods and chopper-controlled resistance techniques for sub-synchronous and super-synchronous speed control of slip ring induction motors.
CO5	Develop open-loop and closed-loop speed control strategies for synchronous and brushless DC motor drives using VSI-fed configurations.
CO6	Evaluate the construction, operating principles, and applications of switched reluctance motors, solar-powered pumps, MPPT, and battery-operated vehicles.

#### Course Contents:

<b>Unit 1: Fundamentals of Electric Drives</b> Types and parts of the Electrical drives, Selection criteria of drives, motor rating, selection based on duty cycle, selection of converter rating, fundamental torque equation, speed torques characteristics DC motor and Induction motor, multi quadrant operation of the drive, classification of mechanical load torques, steady state stability of the drive, constant torque and constant HP operation of the drive, closed loop speed control.	[6]
<b>Unit 2: DC Motor Drives</b> Methods of speed control, starting and braking operation, single phase and three phases full controlled and half controlled converter fed DC drives, Multi quadrant operation of separately excited DC shunt motor, dual converter fed DC drives, circulating and non – circulating mode of operation, converter fed DC series motor drive, chopper control of DC shunt and series motor drives, four quadrant operation of chopper fed DC shunt motor drive.	[6]
<b>Unit 3: Induction Motor Drives</b> Torque equation, Speed control methods for three phase cage induction motor, braking methods, stator voltage control induction motor drive, VSI fed induction motor drive, constant torque (constant E/F and constant V/F), constant HP operation, closed loop speed control block diagram, Stator current control methods fed induction motor drive, speed torque characteristics of CSI fed drive, closed loop speed control block diagram,	[7]



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comparison of CSI fed and VSI fed induction motor drive.	
<b>Unit 4: Slip Ring Induction Motor Drives</b> Chopper controlled resistance in rotor circuit, slip power recovery using converter cascade in rotor circuit, sub synchronous and super synchronous speed control, Kramer speed control, cyclo - converter in rotor circuit.	[5]
<b>Unit 5: Synchronous Motor Drives and Brushless DC Motor Drives</b> VSI fed synchronous motor drives, true synchronous and self-control mode, open loop and closed loop speed control of Permanent magnet synchronous machine, brushless DC motor drives.	[6]
<b>Unit 6: Special Drives</b> Construction and operating principle of switched reluctance motors, Current / Voltage control, torque equation, converter circuits, operating modes and applications of switched reluctance motors. Solar panel VI characteristics, solar powered pump, maximum power point tracking and battery-operated vehicles.	[6]
<b>Textbooks:</b> 1. G. K. Dubey, Fundamentals of Electrical Drives, Narosa publication.	
<b>Reference Books:</b> 1. N. Mohan T.M. Undel and W. P. Robbins, Power Electronics - Converter Application, John Wiley and sons. 2. Vinod Kumar, Ranjan Kumar Behera, Dheeraj Joshi, Ramesh Bansal, Power Electronics, Drives, and Advanced Applications, CRC Press.	



## Control Systems

23EE3602	PCC	Control Systems	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3hrs/week	CA1:10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Network Analysis, Engineering Mathematics-I and II

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Explain the fundamental concepts and classifications of control systems, along with their applications and mathematical representations and solve the transfer function of the system using block diagram reduction techniques and signal flow graph method.
CO2	Analyze time domain responses and feedback characteristics to evaluate system performance.
CO3	Examine the stability of control systems using Routh-Hurwitz method, root locus method, Nyquist plot, Bode plot, and Polar plot.
CO4	Evaluate the impact of PID controllers and compensators on system performance.
CO5	Develop state-space models and control strategies to enhance controllability and observability.

**Course Contents:**

<b>Unit 1: Introduction to Control System</b> Importance of Control Systems, Classification of control systems, Open loop system, closed loop system, Applications, Mathematical representation and Transfer function of mechanical, electrical systems, Hydraulic and Pneumatic Systems, Block diagram representation and reduction, Signal flow graph, Mason's gain formula, Numerical Problems	[8]
<b>Unit 2: Time Domain Analysis</b> Time Response, Steady state analysis, Transient response analysis, Transient response Specifications, Feedback characteristics of Control System, Numerical Problems.	[7]
<b>Unit 3: Stability Analysis</b> Concept of stability, Routh-Hurwitz stability criteria, Special cases of Routh's criteria, Root Locus method, Effect of pole-zero addition on root locus, Numerical Problems.	[6]
<b>Unit 4: Frequency Domain Analysis</b> Correlation between time domain and frequency domain specification, Polar plot, Nyquist plot, Bode plot, Numerical Problems.	[8]



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<b>Unit 5: PID Controller</b> Introduction to P, I and D controller, Individual effect on overall system performance, PI, PID controller and effect on overall system performance, Numerical Problems, Introduction to compensators.	<b>[6]</b>
<b>Unit 6: State Space Analysis</b> Representation of system in state space, converting transfer function model in to state space model, Non uniqueness of state space model, State space representation, Solution of state equations, State Transition Matrix, Controllability and Observability Test.	<b>[7]</b>
<b>Textbooks:</b> <ol style="list-style-type: none"><li>1. I. J. Nagrath, M. Gopal, Control System Engineering, New Age Int. Publishers, 5<sup>th</sup> Ed., 2008.</li><li>2. M. Gopal, Control System: Principles and Design, Tata Mc Graw-Hill Publication.</li><li>3. K. Ogata, Modern Control Engineering, Eastern Economy, 5<sup>th</sup> Edition, 2011.</li><li>4. S. K. Bhattacharya, Control Systems Engineering, Pearson, 2013.</li><li>5. A. Nagoor Kani, Control Systems, RBA Publications.</li></ol>	
<b>Reference Books:</b> <ol style="list-style-type: none"><li>1. Katsuhiko Ogata, Modern Control Engineering, Prentice Hall, 2010.</li><li>2. B. C. Kuo, Automatic Control System, Wiley Publication 8<sup>th</sup> Edition.</li><li>3. Norman S. Nise, Control System Engineering, John Wiley and Sons, 6<sup>th</sup> Edition, 2014.</li><li>4. M. Gopal, Digital Control and State Variable Methods, Tata Mc Graw Hill, 3<sup>rd</sup> Edition.</li></ol>	



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### Microcontroller and Applications

23EE3603	PCC	Microcontroller and Applications	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Analog and Digital Electronics

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Explain addressing modes and the role of key components like PSW, SFR, ports, and clock circuits
CO2	Develop proficiency in Embedded C programming for basic I/O operations and timer/counter functionalities of the 8051 microcontroller.
CO3	Understand interrupt structures, priorities, and ISR development, showcasing skills in external and timer interrupts programming.
CO4	Analyze Peripheral Interfacing such as LCDs, ADCs, DACs, and stepper motors with microcontrollers, along with relevant programming techniques.
CO5	Demonstrate expertise in interfacing DC motors, temperature sensors, and relays, as well as implementing PWM programming and hardware-in-loop simulations for power electronics applications.
CO6	Evaluate advanced microcontroller platforms like ARM, PIC, and MSP430, focusing on features, architecture, and low-power operation capabilities.

#### Course Contents:

<b>Unit 1: Microcontroller Basics</b> Overview of 8051, features, Architecture, Pin out and pin functions, program memory, data memory, SFR area, PSW, Code memory space,(Internal/External), Port structure, clock circuit, Addressing Modes.	[6]
<b>Unit 2: Programming Ports and Timers</b> Introduction to Embedded C programming, Basic I/O programming, Development tools for 8051 programs, Programming Timers and counters Timer block diagram and function, Timer modes 0, 1, 2 and their Applications, Timer and Counter Programming.	[6]
<b>Unit 3: Interrupts and Serial Communication</b> Interrupt structure, Writing ISR, interrupt, Interrupt priorities, Programming for external interrupt. Programming timer interrupts. Serial Communication: Serial communication modes, RS232 signals of PC, Programming through Serial communication.	[7]
<b>Unit 4: Peripheral Interfacing- I</b> Interfacing of microcontrollers to external peripherals and programming, LCD interfacing, Interfacing of Analog to Digital Converters and Digital to Analog Converters, Stepper motor interfacing.	[6]
<b>Unit 5: Peripheral Interfacing- II</b> DC motor interfacing, PWM programming using microcontrollers, Use of microcontroller	[6]



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in Power Electronics Applications, Interfacing Temperature Sensors, Relay Interfacing, concept of hardware-in-loop simulation, programming examples.	
<b>Unit 6: Introduction to Advanced microcontrollers</b> Introduction to ARM and PIC processors of MSP 430 microcontroller, 16 bit Micro-controllers, overview, features, architecture, addressing modes, Low power operation feature of MSP 430.	[6]
<b>Textbooks:</b>  1. Muhammad Mazidi, Janice Mazidi and Rolin McKinlay, The 8051 Microcontroller and Embedded systems using Assembly and C, Pearson Education, 2007. 2. Kenneth Ayala, 8051 Architecture, Programming and Application, Delmar Thomson Learning, 1999.	
<b>Reference Books:</b>  1. Subrata Ghoshal, Embedded Systems and Robots: Projects using the 8051 Microcontroller, 1 <sup>st</sup> Edition, Cengage Learning, 2009 2. Mazidi, Rolin Mc Kinlay and Danny Causey, PIC Microcontroller and Embedded Systems using Assembly and C for PIC18, Pearson Education, 2 <sup>nd</sup> Edition, 2021. 3. Andrew N. Sloss, Dominic Symes, Chris Wright, ARM System Developer's Guide: Designing and Optimizing System Software, Elsevier, 1 <sup>st</sup> Edition, 2004. 4. Texas Instruments MSP 430 microcontroller: Guide and Datasheets	



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**Program Elective Course-II: Utilization of Electrical Energy**

23EE3603A	PEC	Utilization of Electrical Energy	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Nil

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Analyze the principles, efficiency, and applications of electric heating methods and types of welding in industrial scenarios.
CO2	Evaluate DC and AC traction systems, traction motors, and energy consumption metrics for modern transportation solutions like electric vehicles and high-speed rail.
CO3	Apply advanced energy-efficient motor control techniques to optimize the performance of DC and AC motors controlled by variable frequency drives for industrial applications.
CO4	Analyze power factor correction, energy audit data, and smart grid integration to optimize electrical utilization and address power quality issues for energy conservation.
CO5	Design lighting solutions for residential, industrial, and commercial applications using laws of illumination and advanced smart lighting technologies.
CO6	Evaluate renewable energy systems combined with smart metering, demand response techniques, and digital technologies to enhance energy optimization and sustainability.

**Course Contents:**

<b>Unit 1: Electric Heating and Welding</b> Principles of resistance heating (Direct and Indirect), Induction heating and applications, Dielectric heating and microwave heating, Efficiency, advantages, and comparison with conventional heating methods, Types of welding: Arc welding, resistance welding, ultrasonic welding, Industrial applications of electric heating and welding	[6]
<b>Unit 2: Electric Traction and Transportation Systems</b> DC vs. AC Traction Systems, Types of Traction Motors: DC Series, Induction, and Synchronous Motors, Speed-time curves and energy consumption in traction, Metro Rail, High-Speed Rail, Maglev, and Electric Vehicles, Comparison with traditional, fuel-based transportation, Battery storage, charging infrastructure, Smart grid integration for electric mobility	[6]
<b>Unit 3: Industrial Electric Drives</b> Types of Electric Drives and Their Applications, Motor Selection for Industrial Applications, DC Motor Speed Control, AC Motor Speed Control (V/F Control), Introduction to Variable Frequency Drives (VFDs), Energy Efficiency in Industrial Motor Applications	[7]
<b>Unit 4: Energy Conservation and Power Quality</b> Importance of Energy Conservation in Electrical Utilization, Power Factor Correction and Improvement, Energy Audits and Demand-Side Management (DSM), Power Quality Issues and Harmonic Mitigation, Energy-Efficient Appliances and Smart Grid Integration	[6]



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<b>Unit 5: Illumination and Lighting Systems</b> Luminous Flux, Luminous Intensity, Luminance, Lux , Laws of Illumination (Inverse Square Law, Lambert's Cosine Law), Incandescent, Fluorescent, LED, HID Lighting Street Lighting, Industrial Lighting, Commercial Lighting, Smart Lighting and Control Systems	[5]
<b>Unit 6: Renewable Energy and Smart Energy Utilization</b> Solar, wind, and hybrid energy systems, Grid-connected vs. off-grid renewable systems, Smart metering and automation in energy consumption, Demand response techniques in smart grids, AI, blockchain, and digital twin technologies for energy optimization; Smart homes, industries, and smart grid innovations.	[6]
<b>Textbooks / Reference Books:</b> 1. H. Partab, Art and Science of Utilization of Electrical Energy, Dhanpat Rai and Co. (P) Ltd, 1st Edition, 2015 2. E. Openshaw Taylor, Utilization of Electric Energy, Orient Blackswan Private Limited, 1st Edition, 2013 3. S. Sivanagaraju, M. Balasubba Reddy, D. Srilatha, Generation and Utilization of Electrical Energy, Pearson Education, 1 <sup>st</sup> Edition, 2010. 4. C.L. Wadhwa, Generation, Distribution and Utilization of Electrical Energy, Publisher: New Age International Pvt Ltd, 1 <sup>st</sup> Edition, 2010. 5. Sunil S. Rao, Utilization, Generation and Conservation of Electrical Energy, Khanna Publishers, 1 <sup>st</sup> Edition, 2016.	



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**Program Elective Course-II: Special Electrical Machines**

23EE3603B	PEC	Special Electrical Machines	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** DC Machines and Transformers and AC Machines

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Analyze the characteristics, construction, and applications of permanent magnet machines and BLDC motors in industrial drives and consumer electronics.
CO2	Apply open-loop and closed-loop control techniques, including microstepping and PWM, for stepper motor applications in robotics and automation to enhance operational efficiency.
CO3	Evaluate torque production, characteristics, and control methods of switched reluctance motors in industrial and high-speed applications.
CO4	Compare rotary and linear motor systems, including LIM and LSM, to develop solutions for propulsion and material handling applications.
CO5	Design high-efficiency motors and superconducting systems for applications in power generation, wind turbines, and energy storage.
CO6	Apply advanced control techniques, including fuzzy logic and IoT-based monitoring, to optimize the performance and predictive maintenance of special electrical machines.

**Course Contents:**

<p><b>Unit 1: Permanent Magnet Machines</b>            Types of permanent magnets and their characteristics, Magnetic circuits in permanent magnet machines, Construction and working principle, EMF equation and torque production, Applications in industrial drives and electric vehicles, BLDC motor construction and working, Comparison between BLDC and conventional DC motors, Applications in robotics, aerospace, and consumer electronics</p>	[6]
<p><b>Unit 2: Stepper Motors and Their Applications</b>            Types: Permanent Magnet (PM), Variable Reluctance (VR), and Hybrid Stepper Motors, Step angle, torque-speed characteristics, Open-loop and closed-loop control, Microstepping and pulse-width modulation (PWM) control techniques, Use in robotics, CNC machines, and automation systems</p>	[6]
<p><b>Unit 3: Switched Reluctance Motors</b>            Basic working and torque production, Characteristics and advantages of SRM, Power electronic converters for SRM, Torque ripple reduction and control methods, Industrial automation, electric vehicles, and high-speed applications</p>	[7]
<p><b>Unit 4: Linear Motors and Actuators</b>            Difference between rotary and linear motors, Classification: Linear Induction Motor, (LIM), Linear Synchronous Motor (LSM), Propulsion systems (Maglev, high-speed trains), Material handling and conveyor belt drives, Basics of piezoelectric actuators High-precision positioning systems</p>	[6]



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<b>Unit 5:High-Efficiency and Superconducting Machines</b> High-efficiency standards (IE2, IE3, IE4 motors), Loss reduction techniques, Introduction to superconducting materials, Applications in power generation and high-torque motors Wind turbine generators, Superconducting magnetic energy storage (SMES)	[5]
<b>Unit 6:Control and Emerging Trends in Special Electrical Machines</b> Fuzzy logic and artificial intelligence-based motor control, Sensorless control techniques IoT-enabled motor monitoring and predictive maintenance, Data analytics for fault detection and performance optimization, Soft magnetic materials for high-performance machines, Bio-inspired actuators and robotics applications	[5]
<b>Textbooks:</b> 1. K. Venkataratnam, Special Electrical Machines, Universities Press, 1 <sup>st</sup> Edition, 2008 2. R. Krishnan, Electric Motor Drives: Modeling, Analysis, and Control, Pearson Education India, 1 <sup>st</sup> Edition, 2015 3. T. J. E. Miller, Brushless Permanent Magnet and Reluctance Motor Drives, Clarendon Press, 1 <sup>st</sup> Edition, 1999	
<b>Reference Books:</b> 1. T.J.E. Miller, Switched Reluctance Motors and Their Control, Oxford University Press, 1 <sup>st</sup> Edition, 1993. 2. V. V. Athani, Stepper Motors: Fundamentals, Applications, and Design, New Age International, 1 <sup>st</sup> Edition, 2009. 3. R. Krishnan, Permanent Magnet Synchronous and Brushless DC Motor Drives, CRC Press, 1 <sup>st</sup> Edition, 2016. 4. Jacek F. Gieras, Linear Electric Machines, Drives, and Maglev Transportation, Springer, 1 <sup>st</sup> Edition, 2012.	



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**Program Elective Course-II: Linear Integrated Circuits**

23EE3604C	PEC	Linear Integrated Circuits	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Analog and Digital Electronics, Basic Electronics Engineering

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Analyze the internal architecture, characteristics, and operational principles of op-amps, focusing on IC 741 circuit diagrams and performance metrics.
CO2	Apply practical circuits such as instrumentation amplifiers, integrators, differentiators, and converters to solve application-specific challenges effectively.
CO3	Design filter circuits, including low-pass, high-pass, and band-pass filters, alongside amplifiers and signal conditioning devices.
CO4	Evaluate the functionality and specifications of DACs and ADCs, emphasizing their operational modes and applications in signal processing.
CO5	Design waveform generators using sine-wave, triangular, and saw-tooth wave circuits to produce desired signals for various applications.
CO6	Apply IC voltage regulators, switching regulators, and audio power amplifiers to optimize circuits for specific operational requirements.

**Course Contents:**

<b>Unit-I Basics of OP-AMP:</b> Current mirror and current sources, Current sources as active loads, Voltage sources, Voltage References, Basic information about op-amps – Ideal Operational Amplifier – General operational amplifier stages -and internal circuit diagrams of IC 741, DC and AC performance characteristics, slew rate.	[7]
<b>Unit II Applications of OP-AMP:</b> Sign Changer, Scale Changer, Phase Shift Circuits, Voltage Follower, V-to-I and I-to-V converters, adder, subtractor, Instrumentation amplifier, Integrator, Differentiator.	[6]
<b>Unit III Filter Circuits Using OP-AMP:</b> Logarithmic amplifier, Antilogarithmic amplifier, Comparators, Schmitt trigger, Precision rectifier, peak detector, clipper and clamper, Low-pass, high-pass and band-pass filters.	[6]
<b>Unit IV Analog To Digital And Digital To Analog Converters:</b> Analog and Digital Data Conversions, D/A converter – specifications – weighted resistor type, R-2 Ladder type, Voltage Mode and Current-Mode R – 2R Ladder types – switches for D/A converters high speed sample-and-hold circuits, A/D Converters – specifications – Flash type – Successive Approximation type	[8]
<b>Unit V Waveform Generators:</b> Sine-wave generators, Multivibrators and Triangular wave generator, Saw-tooth wave generator, ICL8038 function generator, Timer IC 555	[6]



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<b>Unit VI Special Function IC's:</b> IC Voltage regulators – Three terminal fixed and adjustable voltage regulators – IC 723 general purpose regulator – Monolithic switching regulator, Low Drop-Out (LDO) Regulators – Switched capacitor filter IC MF10, Audio Power amplifier.	[7]
<b>Textbooks:</b>  1. David Bell, Operational Amplifier and Linear Integrated Circuits, Oxford University Press, 3 <sup>rd</sup> Edition, 2011. 2. Ramakant A. Gaikwad, OP-AMPS and Linear Integrated Circuit Technology, Pearson, 2020	
<b>Reference Books:</b>  1. Roy Choudhary, Shail B Jain, Linear Integrated Circuits, New Age International Pvt Ltd, 6 <sup>th</sup> Edition, 2022. 2. R. P. Punagin, Linear Integrated Circuits and Applications, I K International Publishing House, 1 <sup>st</sup> Edition, 2013. 3. K. Salivahan, Linear Integrated Circuits, TMH Education, 3 <sup>rd</sup> Edition, 2012. 4. William D Stanley, Operational Amplifier with linear Integrated Circuits, Pearson, 4 <sup>th</sup> Edition, 2001.	



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**Program Elective Course-II: E-Mobility**

23EE3604D	PEC	E-Mobility	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Basic Electrical Engineering, Electrical Machines, Power Electronics

**Course Outcomes:** At the end of the course, the students will be able to:

CO1	Analyze the evolution of electric mobility, its impact on the environment, economic dimensions, and the challenges associated with its adoption and technologies.
CO2	Determine the battery parameters used in different batteries with EVs.
CO3	Identify the motors for drive technologies to EVs (BEV, HEV and FCEV).
CO4	Demonstrate the power electronics convertors used for EVs.
CO5	Model vehicle dynamics, including tractive effort, aerodynamics, and range performance parameters, to predict the behaviour and efficiency of battery and hybrid electric vehicles.
CO6	Apply communication techniques such as V2V, V2G, and wireless power transfer to improve energy management and infrastructure integration for electric vehicles.

**Course Contents:**

<b>UNIT-I: INTRODUCTION</b> Understand Mobility and its evolutions, Electric Mobility and Environmental Impact Reduction, Economic Analysis, Electric Mobility and Infrastructures: Technical and Economic Dimensions, Electric Mobility Today, Prospective: The Road to Electrification, Overview of EVs and challenges, and Technologies.	[6]
<b>UNIT-II: BATTERIES</b> <b>Batteries:</b> Electrochemical Batteries: Battery Parameters: Battery Capacity, Open Circuit and Terminal Voltages, Charge/Discharge Rate, State of Charge/Discharge, Depth of Discharge, Battery Energy Density and Specific Energy, Battery Power Density and Specific Power, Battery Efficiency, Electrochemical Batteries-Types, Ultracapacitors, Ultrahigh-Speed Flywheels, Numerical Problems.	[6]
<b>UNIT-III: ELECTRIC AND HYBRID POWERTRAIN TECHNOLOGIES</b> Introduction, BEVs, Electric Traction Motors, DC Motors-BLDC Motor, AC Motors-IM, PMSM, SR Motors, Energy sources and Energy carriers, Hybrid Electric Vehicles (HEV), Plug-in Hybrid Electric Vehicles (PHEV), FCEV.	[6]
<b>UNIT-IV: POWER-ELECTRONIC CONVERTERS FOR EV APPLICATIONS</b> DC/DC Converters: Non-isolated converters: buck, boost, buck-boost, Cuk and charge-pump converters; bi-directional converters; Isolated converters: Half-Bridge, Full-Bridge, Fly-back, Forward and Push-Pull DC/DC converters; DC/AC Converter.	[7]
<b>Unit-V: ELECTRIC VEHICLE MODELLING</b> Introduction, Tractive Effort, Rolling resistance force, Aerodynamics, Hill climbing force,	[7]



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Acceleration force, Total tractive effort , Modelling Vehicle Acceleration, Acceleration performance parameters, Modelling the acceleration of an electric scooter, Modelling the acceleration of a small car, Range modelling of battery electric vehicles, Range modelling of hybrid electric vehicles.	
<b>UNIT-VI: EV COMMUNICATION</b> Basic Communication, V2V, V2G and its applications in power system - power saving and coordinated charging - layout of power converters for V2G operation, EV configurations: converted and purpose built EVs components of EV system, Wireless Power Transfer: Principle, Stationary WPT, and Dynamic WPT.	[6]
<b>Textbooks:</b> 1. James Larminie and John Lowry, Electric-Vehicle-Technology-Explained, John Wiley and Sons Ltd, 2012. 2. Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2010.	
<b>Reference Books:</b> 1. Electric and Hybrid Vehicles Power Sources, Models, Sustainability, Infrastructure and the Market Gianfranco Pistoia Consultant, Rome, Italy, Elsevier Publications, 2017. 2. Mehrdad Ehsani, Yimin Gao, Stefano Longo, Kambiz M. Ebrahimi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, CRC Press,2018. 3. Wei Liu, Hybrid Electric Vehicle System Modelling and Control, John Wiley and Sons, Inc., 2017.	



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### Financial Literacy

23EE3605	VSEC	Financial Literacy	2-0-0	2 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 2 hrs/week	CA1: 25 Marks CA2: 25 Marks

**Pre-Requisites:** Nil.

**Course Outcomes:** At the end of the course, the students will be able to:

CO1	Explain key financial concepts, including financial literacy, time value of money, components of the financial system, types of banking services, and financial products such as loans, insurance, and investments, and understand their significance in personal financial planning.
CO2	Apply financial principles to real-world scenarios by calculating values such as present and future worth, comparing financial products and services, analyzing risks and benefits, and making informed decisions about investments, loans, and insurance options based on individual financial goals.
CO3	Evaluate the effectiveness of various financial products and services, critically assess their suitability for different needs, and design comprehensive financial strategies that integrate savings, investment, insurance, and loan options to optimize personal financial security and growth.

**Course Contents:**

<p><b>Unit 1: Introduction</b>            Meaning, importance and scope of financial literacy; Prerequisites of Financial Literacy – level of education, numerical and communication ability; Time Value of Money – future and present value of a lump-sum and variable amount, annual and multiple compounding and discounting.</p>	[4]
<p><b>Unit2: Financial System</b>            Concept of financial system, an overview of financial system, brief discussion on components of financial system – Financial Institutions, Financial Markets and Financial Instruments; Concept of Investment and characteristics, and types of risks involved in financial investment; Capital Market – Primary Market and Secondary Market, procedure to make investment in equity in primary and secondary market.</p>	[4]
<p><b>Unit3: Banking Services</b>            Types of banks; Banking products and services – Various services offered by banks; Types of bank deposit accounts – Savings Bank Account, Term Deposit, Current Account, Recurring Deposit, PPF, NSC etc.; Formalities to open various types of bank accounts, PAN Card, Address proof, KYC norm; Various types of loans – short term, medium term, long term, micro finance, agricultural etc. and related interest rates offered by various nationalized banks and post office; Cashless banking, e-banking, Check Counterfeit</p>	[5]



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<p>Currency; CIBIL, ATM, Debit and Credit Card, and APP based Payment system; Banking complaints and Ombudsman.</p>	
<p><b>Unit 4: Financial Services from Post Office</b>          Post office Savings Schemes: Savings Bank, Recurring Deposit, Term Deposit, Monthly Income Scheme, Kishan Vikas Patra, NSC, PPF, Senior Citizen Savings Scheme (SCSS), Sukanya Samridhi Yojana/Account (SSY/SSA); India Post Payments Bank (IPPB).          Money Transfer: Money Order, E-Money order. Instant Money Order, collaboration with the Western Union Financial Services; MO Videsh, International Money Transfer Service, Electronic Clearance Services (ECS), Money gram International Money Transfer, Indian Postal Order (IPO)</p>	[4]
<p><b>Unit-5: Protection Related Financial Services:</b>          Insurance Services: Life Insurance Policies: Life Insurance, Term Life Insurance, Endowment Policies, Pension Policies, ULIP, Health Insurance and its Plans, Comparison of policies offered by various life insurance companies; Property Insurance: Policies offered by various general insurance companies. Post office life Insurance Schemes: Postal Life Insurance and Rural Postal Life Insurance (PLI/RPLI); Housing Loans: Institutions providing housing loans, Loans under Pradhan Mantri Awas Yojana –Rural and Urban; Motor Insurance, and Home Insurance</p>	[5]
<p><b>Unit-6: Investment Related Financial Services:</b>          Investment avenues in Equity and Debt Instruments: Portfolio Management: Meaning and importance; Share Market and Debt Market, Sensex and its significance; Investment in Shares –selection procedure for investment in shares; Risk element; Investment Management -Services from brokers and Institutions, and self-management and Mutual Funds; Bonds, Public Provident Fund (PPF), National Savings Certificate (NSC), Exchange-Traded Funds (ETFs); Retirement and Pension Products: National Pension Scheme (NPS), Employees' Provident Fund (EPF), Annuities</p>	[5]
<p><b>Textbooks:</b></p> <ol style="list-style-type: none"> <li>1. Gordon and Natarajan, Financial Markets and Services, Himalaya Publishing House Pvt. Ltd, Mumbai, 2015.</li> <li>2. Kothari, R., Financial Services in India-Concept and Application, Sage Publications India Pvt. Ltd., New Delhi, 2010.</li> <li>3. Avadhani, V. A., Investment Management, Himalaya Publishing House Pvt. Ltd., Mumbai, 2019.</li> <li>4. Kevin S, Portfolio Management, PHI, New Delhi.</li> </ol>	
<p><b>Reference Books:</b></p> <ol style="list-style-type: none"> <li>1. Prasanna Chandra, Investment Analysis and Portfolio Management, Tata McGraw-Hill Publishing Company Limited, New Delhi.</li> <li>2. Chandra, P. (2012). Investment Game: How to Win, Tata McGraw Hill Education, New Delhi.</li> <li>3. Mittra, S., Rai, S. K., Sahu, A. P., and Starn, H. J., Financial Planning, Sage Publications India Pvt. Ltd., New Delhi, 2015.</li> <li>4. Zokaityte, A., Financial Literacy Education, Palgrave Macmillan, London, 2017.</li> </ol>	



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### Electrical Drives Laboratory

23EE3606	PCC	Electrical Drives Laboratory	0-0-2	1 Credits
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Teaching Scheme	Evaluation Scheme
Practical: 2hr/week	CA1:15 Marks CA2: 15 Marks End Semester Exam: 20 Marks

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Apply speed control techniques for various motors, including single-phase induction motors using VFD, and three-phase slip-ring motors using static Scherbius drives.
CO2	Analyze advanced motor drive systems, including DC-DC converter drives, stepper motor drives, and three-phase induction motor drives, to evaluate their performance.
CO3	Examine the performance of AC and DC drives using simulation tool.

#### Course Contents:

**List of Experiments:** Minimum of 8 experiments should be performed from the following list.

1. To study speed control of single phase induction motor using VFD.
2. Speed control of three phase slip-ring motor using static scherbius drive
3. To perform speed control of separately excited dc motor using chopper.
4. Closed loop and open loop speed control of dc motor.
5. To perform Micro controller based speed control of 3 phase induction motor by stator voltage control.
6. Controlled Converter fed stepper motor drive.
7. Simulation of 3 phase induction motor drives.
8. Simulation of DC-DC converter drives.
9. Simulation of Stepper motor drives.

#### Textbooks/Reference Books:

1. G. K. Dubey, Fundamentals of Electrical Drives, Narosa publication.
2. N. Mohan T.M. Undel and W. P. Robbins, Power Electronics - Converter Application, John Wiley and sons.



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**Control Systems Laboratory**

23EE3607	PCC	Control Systems Laboratory	0-0-2	1 Credit
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Teaching Scheme	Evaluation Scheme
Practical: 2 hrs/ week	CA1: 25 Marks CA2: 25 Marks

**Pre-Requisites:** Network Analysis, Engineering Mathematics-I and II

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Demonstrate the use of MATLAB control system and Simulink toolboxes for analyzing and simulating linear time-invariant systems and block diagram reductions.
CO2	Evaluate the stability of linear systems by employing MATLAB tools such as Root Locus, Bode Plot, Polar Plot, and Nyquist Plot for second- and third-order systems.
CO3	Develop state models, transfer functions, and PID controllers using MATLAB to improve system performance and control strategies.

**Course Contents:**

**List of Experiments:** Minimum of 8 experiments should be performed from the following list.

1. Familiarization with MATLAB control system toolbox, MATLAB Simulink toolbox.
2. Linear Time-invariant Systems and Representation using MATLAB
3. Block Diagram Reduction using MATLAB
4. Time Response of Second Order System using MATLAB
5. Simulation of Step response and impulse response for type-0, type-1 and type-2 system with unity feedback using MATLAB
6. Determination of stability by using Root locus using MATLAB for 2<sup>nd</sup> and 3<sup>rd</sup> order system of a Linear Time Invariant System.
7. Determination of stability by using Bode plot using MATLAB for 2<sup>nd</sup> and 3<sup>rd</sup> order system of a Linear Time Invariant System.
8. Determination of stability by using Polar plot using MATLAB for 2<sup>nd</sup> and 3<sup>rd</sup> order system of a Linear Time Invariant System.
9. Determination of stability by using Nyquist plot using MATLAB for 2<sup>nd</sup> and 3<sup>rd</sup> order system of a Linear Time Invariant System.
10. State Model for Classical Transfer Function and Vice-Versa Using MATLAB.
11. PID Controller using MATLAB



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**Textbooks:**

1. I. J. Nagrath, M. Gopal, "Control System Engineering", New Age International Publishers – Fourth edition
2. M. Gopal, Control system: Principles and Design, Tata Mc Graw-Hill Publication
3. K. Ogata, Modern Control Engineering, Eastern Economy, 5<sup>th</sup> Edition 2011.
4. I. J. Nagrath and M. Gopal, Control System Engineering, New Age Publication, 5<sup>th</sup> edition, 2008.

**Reference Books:**

1. Katsuhiko Ogata, Modern Control Engineering, Prentice Hall, 2010
2. B. C. Kuo, Automatic Control System, Wiley Publication 8<sup>th</sup> Edition.
3. Norman S. Nise, Control System Engineering, John Wiley and Sons, 6<sup>th</sup> Edition, 2014.
4. M.Gopal, Digital Control and State Variable Methods, Tata Mc Graw Hill, 3<sup>rd</sup> Edition.



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**Microcontrollers and Applications Laboratory**

23EE3608	PCC	Microcontrollers and Applications Laboratory	0-0-2	1 Credit
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Teaching Scheme	Evaluation Scheme
Practical: 2hr/week	CA1: 15 Marks CA2: 15 Marks End Semester Exam: 20 Marks

**Pre-Requisites: Analog and Digital Electronics**

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Develop assembly language programs for 8085 microprocessor to perform arithmetic and logical operations.
CO2	Design microcontroller-based systems using 8051 to implement tasks such as rolling displays, LED flashing, motor speed control, and automatic street lighting.
CO3	Develop Arduino-based control systems for applications like IR obstacle detection, relay control, and temperature-controlled fan operations.

**Course Contents:**

**List of Experiments:** Minimum of 8 experiments should be performed from the following list.

1. Assembly language program's for 8085 arithmetic operations
2. Assembly language program's for 8085 logical operations
3. Rolling display using 8051 microcontroller
4. led flashing using 8051 microcontroller
5. Speed and direction control of dc motor using 8051 microcontroller
6. Speed and direction of stepper motor using 8051 microcontroller
7. Automatic Street light control using 8051 microcontroller
8. Seven segment display using 8051 microcontroller
9. IR obstacle sensor using Arduino microcontroller
10. Relay control using Arduino microcontroller
11. Temperature controlled fan using Arduino microcontroller

**Textbooks/Reference Books:**

1. Muhammad Mazidi, Janice Mazidi and Rolin McKinlay, The 8051 Microcontroller and Embedded systems using Assembly and C, Pearson Education, 2007.
2. Kenneth Ayala, 8051 Architecture, Programming and Application, Delmar Thomson Learning, 1999.



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**Multidisciplinary Minor -IV: Industrial System Design**

23EEMDA4	MDM	Industrial System Design	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Electrical System Planning and Design, Electrical Estimation and Costing, Lighting System Design

**Course Outcomes:** At the end of the course, the students will be able to:

CO1	Develop efficient and scalable industrial system designs by applying system engineering concepts and methodologies like top-down and bottom-up approaches.
CO2	Analyze industrial processes using mathematical models and tools like MATLAB, Simulink, and digital twin technology to evaluate system performance.
CO3	Develop industrial control systems using PID controllers, PLCs, and robotics for automation in assembly lines and process plants.
CO4	Apply energy-efficient designs, waste reduction techniques, and sustainable manufacturing practices like lean manufacturing and Six Sigma to enhance industrial processes.
CO5	Evaluate safety standards, reliability engineering metrics, and predictive maintenance strategies using tools like FMEA and IoT sensors.
CO6	Apply CAD/CAM software, simulation tools, and advanced techniques like FEA and CFD to prototype and optimize industrial systems for real-world applications.

**Course Contents:**

<b>Unit 1: Introduction to Industrial System Design</b> Fundamentals of Industrial Systems and their Classifications, Design Considerations: Efficiency, Performance, and Scalability, Concept of System Engineering and Design Process, Design Methodologies: Top-Down vs. Bottom-Up Approaches, Case Study on an Industrial System Development Lifecycle	[6]
<b>Unit2: System Modeling and Simulation</b> Mathematical Modeling of Mechanical, Electrical, and Fluid Systems, Transfer Function Representation and State-Space Analysis, Simulation of Industrial Processes using MATLAB, Simulink , Case Study: Modeling and Simulation of a Manufacturing System , Introduction to Digital Twin Technology in System Design	[6]
<b>Unit3: Industrial Control Systems and Automation</b> Types of Industrial Control Systems: Open-loop vs. Closed-loop, PID Controllers and Their Tuning Methods , PLC-Based Industrial Control Systems , Robotics and Motion Control Systems , Case Study: Automation in Assembly Lines and Process Plants	[6]
<b>Unit 4: Energy-Efficient and Sustainable System Design</b>	[6]



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Principles of Energy-Efficient Industrial Design, Waste Reduction and Sustainable Manufacturing , Optimization Techniques for Industrial Processes , Introduction to Lean Manufacturing and Six Sigma, Case Study: Designing an Energy-Efficient HVAC System	
<b>Unit-5: Safety, Reliability, and Maintenance in Industrial Systems</b> Industrial Safety Standards and Regulations (ISO, OSHA) , Failure Modes and Effects Analysis (FMEA), Reliability Engineering: MTBF, MTTR, and Fault Tree Analysis Predictive Maintenance using Machine Learning and IoT Sensors, Case Study: Risk Assessment in Industrial System Design	[6]
<b>Unit-6: Software Tools for Industrial System Design</b> CAD/CAM Software for Industrial System Prototyping, Industrial Process Simulation using ANSYS, AutoCAD, Solid Works, Introduction to Finite Element Analysis (FEA) and Computational Fluid Dynamics (CFD), System Optimization Techniques Using AI and Big Data, Final Project: Design an optimized industrial system for a real-world application.	[6]
<b>Textbooks:</b> 1. Benjamin S. Blanchard, System Engineering for Manufacturing, 5 <sup>th</sup> Edition, Pearson, 2010. 2. Michael L. George, Lean Manufacturing and Six Sigma in System Design, 1 <sup>st</sup> Edition, McGraw-Hill Education, 2002	
<b>Reference Books:</b> 1 Jerry Banks, Industrial System Simulation and Modeling 2 David R. Gaskell, Industrial System Engineering and Design 3 Thomas J. Allen and David Garlan, Design of Industrial Information Systems, 4 Patrick O'Connor, Reliability and Safety in Industrial Systems	



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**Multidisciplinary Minor -IV: Introduction to Internet of Things**

23EEMDB4	MDM	Introduction to Internet of Things	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Introduction to PLC, SCADA and HMI, Industrial Automation

**Course Outcomes:** At the end of the course, the students will be able to:

CO1	Analyze the evolution, components, applications, and challenges of IoT across various domains, emphasizing its integration with Industry 4.0.
CO2	Apply embedded systems and sensor technologies, including microcontrollers, actuators, and power management techniques, to develop IoT devices.
CO3	Apply IoT communication protocols and models, such as MQTT, CoAP, Wi-Fi, and LPWAN, to ensure efficient data transmission and cloud connectivity.
CO4	Evaluate cloud platforms, edge computing, and AI-based data analytics to optimize IoT data storage, processing, and decision-making.
CO5	Develop encryption, authentication, and secure communication protocols to mitigate IoT security threats while ensuring compliance with privacy regulations.
CO6	Develop end-to-end IoT projects, integrating AIoT and addressing real-world applications like smart cities, autonomous vehicles, and wearable technologies.

**Course Contents:**

<b>Unit 1: Introduction to IoT</b> Definition and Evolution of IoT, Components of IoT: Things, Gateway, Cloud, Analytics, User Interface, IoT Applications in Various Domains: Smart Homes, Healthcare, Agriculture, Industry 4.0 , IoT and Industry 4.0, Challenges and Future Trends in IoT	[6]
<b>Unit2: IoT Hardware and Sensors</b> Embedded Systems for IoT: Microcontrollers (Arduino, ESP8266, ESP32, Raspberry Pi), Types of Sensors: Temperature, Humidity, Motion, Proximity, Pressure, Gas, Light Actuators and Their Role in IoT , Power Management in IoT Devices	[6]
<b>Unit 3: IoT Communication Technologies</b> IoT Communication Models: M2M vs. IoT, Edge vs. Cloud Processing, Wired and Wireless Communication Protocols: Short-range: Wi-Fi, Bluetooth, Zigbee, LoRa, RFID, NFC, Long-range: 4G, 5G, NB-IoT, LPWAN, MQTT and CoAP Protocols, IoT Data Transmission and Cloud Connectivity	[6]
<b>Unit4: IoT Cloud and Data Analytics</b> Introduction to Cloud Computing for IoT, IoT Data Storage and Processing, Cloud Platforms for IoT: AWS IoT, Google Cloud IoT, Azure IoT , Edge Computing and Fog Computing in IoT, IoT Data Analytics and AI in IoT	[6]



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<b>Unit 5:IoT Security and Privacy</b> IoT Security Threats: Device vulnerabilities, network attacks, data breaches , Encryption and Authentication in IoT Devices, Secure IoT Communication Protocols, Privacy Concerns and GDPR Compliance in IoT	[6]
<b>Unit-6:IoT Applications and Project Development</b> Case Studies on Real-world IoT Implementations, Developing an End-to-End IoT Project, Integration of AI with IoT (AIoT), Future of IoT: Smart Cities, Autonomous Vehicles, Wearable Tech, Final Project Presentation and Evaluation	[6]
<b>Textbooks:</b> 1. Raj Kamal, Internet of Things: Architecture, Implementation, and Security, 1 <sup>st</sup> Edition, McGraw-Hill Education 2. David Hanes, Gonzalo Salgueiro, IoT Fundamentals: Networking Technologies, Protocols, and Use Cases, 1 <sup>st</sup> Edition, Cisco Press 3. Peter Waher, Mastering Internet of Things, 1 <sup>st</sup> Edition, Wiley	
<b>Reference Books:</b> 1. Maciej Kranz, Building the Internet of Things, 1 <sup>st</sup> Edition, Wiley 2. Colin Do, Hands-On IoT Solutions with Arduino, ESP32, and Raspberry Pi, 1 <sup>st</sup> Edition, Packt Publishing 3. Brian Russell, IoT Security: Practical Guide to Cybersecurity for IoT Systems, 1 <sup>st</sup> Edition, CRC Press	



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**Multidisciplinary Minor -IV: Operation and Planning of Power System**

23EEMDC4	MDM	Operation and Planning of Power System	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Energy Storage System, Grid Integration of RES, Smart Grid

**Course Outcomes:** At the end of the course, the students will be able to:

CO1	Analyze the structure, components, and challenges of modern power systems, emphasizing the role of EMS and SCADA in grid operation with renewable energy integration.
CO2	Apply forecasting techniques and economic load dispatch methods, including regression analysis and AI-based models, to optimize generator load distribution.
CO3	Apply reactive power compensation techniques, FACTS devices, and automatic generation control to ensure voltage and frequency stability in power systems.
CO4	Evaluate contingency analysis techniques, state estimation methods, and protection mechanisms to enhance power system reliability and security.
CO5	Design expansion plans and optimization strategies for generation and transmission systems using reliability indices and smart grid planning techniques.
CO6	Apply renewable energy sources and advanced technologies like AI and Big Data to improve microgrid management, demand response, and smart grid operations.

**Course Contents:**

<b>Unit 1: Introduction to Power System Operation and Planning</b> Power System Components and Structure, Objectives of Power System Operation and Planning, Challenges in Modern Power Systems, Energy Management Systems (EMS) and SCADA in Power System Operation, Renewable Energy Penetration and Its Impact on Grid Operation	[6]
<b>Unit2: Load Forecasting and Economic Operation</b> Types of Load Forecasting: Short-term, Medium-term, and Long-term, Forecasting Techniques: Regression Analysis, Time Series Methods, Artificial Intelligence-based Models, Economic Load Dispatch (ELD):Optimal Load Distribution among Generators, Classical and Computational Methods (Lambda Iteration, Gradient Search), Unit Commitment: Priority List, Dynamic Programming, and Lagrange Relaxation	[6]
<b>Unit3: Voltage and Frequency Control in Power Systems</b> Concept of Voltage and Frequency Stability, Reactive Power Compensation Techniques, Shunt and Series Compensation, FACTS Devices (STATCOM, SVC), Automatic Generation Control (AGC) and Load Frequency Control (LFC), Primary, Secondary, and Tertiary Control of Frequency	[6]
<b>Unit 4: Contingency Analysis and Power System Security</b> Concept of Power System Security and Reliability, Contingency Analysis Techniques: Single Line Outage, N-1, N-2 Contingency Planning, State Estimation and Real-Time	[6]



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Monitoring, Load Shedding and System Protection Mechanisms	
<b>Unit-5: Power System Reliability and Expansion Planning</b> Reliability Indices: SAIDI, SAIFI, CAIDI, LOLP, LOLE, Generation and Transmission Expansion Planning, Optimization Techniques in Power System Planning, Smart Grid and Distributed Energy Resource (DER) Planning	[6]
<b>Unit-6: Renewable Energy Integration and Smart Grid Planning</b> Impact of Renewable Energy on Power System Operation, Grid Integration of Solar, Wind, and Hybrid Energy Systems, Microgrids and Demand Response Management, Role of Artificial Intelligence and Big Data in Smart Grid Planning, Future Trends in Power System Planning and Operation	[6]
<b>Textbooks:</b> 1. P.S.R. Murthy, Power System Operation and Control, Tata McGraw-Hill Education, 1 <sup>st</sup> Edition 2. Allen J. Wood, Bruce F. Wollenberg, Power Generation, Operation, and Control, 3 <sup>rd</sup> Edition, Wiley. 3. Olle I. Elgerd, Electric Energy Systems Theory, 2 <sup>nd</sup> Edition, McGraw-Hill Education.	
<b>Reference Books:</b> 1. J. Duncan Glover, Mulukutla S. Sarma, Power System Analysis and Design, 5 <sup>th</sup> Edition, Cengage Learning. 2. D.P. Kothari, I.J. Nagrath, Modern Power System Analysis, 4 <sup>th</sup> Edition, McGraw-Hill Education. 3. James Momoh, Smart Grid: Fundamentals of Design and Analysis, 1 <sup>st</sup> Edition, Wiley. 4. H.L. Willis, Power System Planning: Emerging Practices, 1 <sup>st</sup> Edition, CRC Press.	



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### Aptitude Skills-IV

23HSSM07	VEC	Aptitude Skills- IV	1-0-0	Audit
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Teaching Scheme	Evaluation Scheme
Lecture: 1hr/week	CA1:25 Marks CA2: 25 Marks

**Pre-Requisites:** Aptitude Skills-I, II and III

**Course Outcomes:** At the end of the course, students will be able to:

1	Solve the questions on ordering of words and Parts of Speech
2	Organize contents of Business Communications such as CV, emails and letters.
3	Solve the questions based on jumbled paragraphs and reading comprehension.
4	Solve the questions on spotting error and sentence correction.
5	Summarize proceedings of any event or conference.
6	Discuss about current and critical issues during group discussion.

**Course Contents:**

<b>Unit 1</b>	Parts of Speech, Punctuation Word Family (Using the same word as different Parts of Speech)	<b>[2]</b>
<b>Unit 2</b>	Analogy, Letter Writing(Formal), E-Mail Writing, CV Writing	<b>[2]</b>
<b>Unit 3</b>	Reading Comprehension, Paragraph Jumbles	<b>[2]</b>
<b>Unit 4</b>	Spotting Errors(in different parts of sentence),Subject-Verb Agreement Sentence Correction, Sentence Completion	<b>[2]</b>
<b>Unit 5</b>	OneWordSubstitution,NarratingEvents/Reports,Summary/PrecisWriting	<b>[2]</b>
<b>Unit 6</b>	Dialogue writing Group Discussion, Interview Skills (Using formal notations and gestures etc.)	<b>[2]</b>

**Textbooks:**

1. Raymond Murphy, Essential English Grammar with Answers, Murphy
2. Objective General English by R.S.Aggarwal, S Chand Publishing, Revised Edition, 2017

**Reference Books:**

1. Raoand,D,V,Prasada,Wrenandamp;MartinHighSchoolEnglishGrammarandCompositio  
n Book, S Chand Publishing, 2017
2. Murphy, Intermediate English Grammar with Answers, Cambridge University Press, Second Edition



### Language Skills-IV

23HSSM08	HMS06	Language Skills- IV	0-0-2	Audit
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Teaching Scheme	Evaluation Scheme
Practical: 2hrs/week	CA1:25 Marks CA2:25 Marks

**Pre-Requisites:** Language Skills I, II and III

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Make use of Function in Python Programming.
CO2	Make use of Python collections.
CO3	Make use of classes and its objects in python.
CO4	Make use of file and it's handling functions.

#### Course Contents:

1. Write a Python program to define a user-defined function that takes a number as input and returns whether it is even or odd. Call the function and display the result. ○ <i>Concepts: Function definition, arguments, return value.</i>	[2]
2. Create a Python program to define and call a function with default arguments and keyword arguments. ○ <i>Concepts: Function calling, argument types.</i>	[2]
3. Write a Python program using a lambda function to compute the square, cube, and factorial of a given number. ○ <i>Concepts: Lambda function basics</i>	[2]
4. Write a Python program to demonstrate list operations such as creation, adding items, removing an item, slicing, and sorting. ○ <i>Concepts: List constructor, change, remove, sort, list comprehension</i>	[2]
5. Write a Python program to demonstrate the use of tuples and sets. Perform operations such as checking membership, adding/removing elements (set), and iterating. ○ <i>Concepts: Tuple immutability, set operations.</i>	[2]
6. Write a Python program to create a dictionary of employees with their ID as key and name as value. Perform operations like adding a new entry, updating existing, and deleting one. ○ <i>Concepts: Dictionary operations, loop through dictionary.</i>	[2]



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7. Write a Python program to create a class Student with attributes name, roll_no, and a method display(). Create an object and access its members. ○ <i>Concepts: Class, object, method access.</i>	<b>[2]</b>
8. Create a class with an <code>__init__()</code> constructor to initialize data members and a destructor to display a message when the object is deleted. ○ <i>Concepts: Constructor, destructor.</i>	<b>[2]</b>
9. Write a program to demonstrate single inheritance where a class Vehicle is inherited by a class Car. Use <code>super()</code> to access base class methods. ○ <i>Concepts: Inheritance, super().</i>	<b>[2]</b>
10. Write a Python program to open a text file in write mode and write your personal information (name, age, department). Then, read and display the content of the file. ○ <i>Concepts: File open, write, read, file modes.</i>	<b>[2]</b>
11. Write a program to read a file line by line using <code>readline()</code> and count the number of characters in each line. ○ <i>Concepts: File reading, character offset.</i>	<b>[2]</b>
12. Create a program to open a file in append mode and add new content. Use exception handling to manage file not found or access errors. ○ <i>Concepts: File handling with exception management.</i>	<b>[2]</b>
<b>Textbooks:</b> 1. Python Projects, Laura Cassell, Alan Gauld, Wrox publication 2. Murach's Python Programming, Michael Urban, Joel Murach, Murach's Publication.	
<b>Reference Books:</b> 1. Fundamentals of Python, (First Program), K.A. Kambert. Cengage MINDTAP Publication, 2 <sup>nd</sup> Edition.	



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## **Teaching and Evaluation Scheme for Final Year B. Tech**

**Department of Electrical Engineering**  
**Semester: VII**





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Department: Electrical Engineering

Rev: Course Structure/00/2023-24

Class: Final Year B. Tech

Semester: VII

Course Code	Type of Course	Course	Teaching Scheme				Evaluation Scheme					Credits
			L	T	P	Total Hrs.	CA1	CA2	MSE	ESE	Total	
23EE4701	PCC	High Voltage Engineering	3	-	-	3	10	10	30	50	100	3
23EE4702	PCC	Switchgear and Protection	2	-	-	2	10	10	30	50	100	2
23EE4703	PEC	Program Elective Course-III	3	-	-	3	10	10	30	50	100	3
23EE4704	PEC	Program Elective Course-IV	3	-	-	3	10	10	30	50	100	3
23EE4705	RM	Research Methodology	3	-	-	3	10	10	30	50	100	3
23EE4706	PCC	High Voltage Engineering Laboratory		-	2	2	15	15	-	20	50	1
23EE4707	PCC	Switchgear and Protection Laboratory	-	-	2	2	15	15	-	20	50	1
23EE4708	PROJ	Mega Project Phase –II	-	-	4	4	25	25	-	50	100	2
23EE4709	MC	Constitution of India	2	-	-	2	25	25	-	-	50	Audit
23EE4710	RM	Seminar	-	-	2	2	-	-	-	50	50	1
23EEMDX5	MDM	Multidisciplinary Minor-V	3	-	-	3	10	10	30	50	100	3
<b>Total</b>			<b>19</b>	<b>-</b>	<b>10</b>	<b>29</b>	<b>140</b>	<b>140</b>	<b>180</b>	<b>440</b>	<b>900</b>	<b>22</b>

**Multidisciplinary Minor-V**

Electrical System Design (Basket - A)	Automation and IOT (Basket - B)	Renewable Energy Sources and Grid Integration(Basket - C)
Earthing Design (23EEMDA5)	IoT Implementation and Practical Applications(23EEMDB5)	Power Quality Improvement (23EEMDC5)

Program Elective Course-III		Program Elective Course-IV	
A	Digital Control Systems	A	Modern Control Theory
B	Switched Mode Power Supplies	B	Electricity Markets
C	FACTS and HVDC	C	Power System Reliability
D	Electric Vehicle Battery and Chargers	D	Electric Vehicles: Design, Dynamics and Testing



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### High Voltage Engineering

23EE4701	PCC	High Voltage Engineering	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1:10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Electrical Engineering Materials, Power Systems

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Explain electric Stress with conduction and breakdown in gases.
CO2	Explain conduction and breakdown in liquid dielectrics.
CO3	Explain conduction and breakdown in solid dielectrics.
CO4	Compare different techniques of generation in high voltages and currents.
CO5	Illustrate different techniques employed for measurement of high voltages and currents
CO6	Explain insulation coordination and high voltage testing of electrical equipment's.

#### Course Contents:

<p><b>Unit 1: Conduction and Breakdown in gaseous dielectrics:</b>            Electric Field Stresses, Finite Difference Method for electric field computation, Gases as insulating media, Collision Processes, Ionization Processes, Townsend Current Growth Equation, Current Growth in the presence of secondary processes, Townsend's Criterion for Breakdown, Time lags for Breakdown. Streamers Theory for breakdown on gases, Paschens Law, Breakdown in non-uniform fields and Corona discharges.</p>	[7]
<p><b>Unit 2: Conduction and Breakdown in Liquid dielectrics:</b>            Liquids as Insulators- Pure and Commercial liquids, Conduction and Breakdown in Commercial liquids- Purification of Transformer fluids, Conduction and Breakdown in Commercial Liquids, Testing of Insulating Oils (Transformer Fluids).</p>	[6]
<p><b>Unit 3: Conduction and Breakdown in Solid Dielectrics:</b>            Breakdown mechanisms in Solid Dielectrics -Intrinsic Breakdown, Electromechanical Breakdown, Thermal Breakdown, Chemical and Electrochemical Deterioration and Breakdown, Breakdown due to Treeing and Tracking and Internal discharges, Breakdown in Composite Dielectrics- Properties of Composite Dielectrics, Examples of Solid Dielectrics used in practice.</p>	[7]
<p><b>Unit 4: Generation of High Voltages and Currents:</b>            Generation of High Direct Current Voltages- Half and Full wave rectifiers, Voltage Doublers Circuits, Voltage Multiplier Circuits- Cockcroft Walton voltage multiplier,            Generation of High Alternating Voltages- Cascaded Transformer Connection, Resonant Transformers, Generation of High Frequency AC High Voltages, Multistage Impulse Generators- Marx Circuit.</p>	[7]



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<b>Unit5: Measurement of High Voltages and Currents-</b> High Ohmic Series Resistance with Micro ammeter, Resistance Potential Divider for DC Voltages, Measurement of High AC and Impulse voltages, Measurement of High-Power frequency alternating currents.	[3]
<b>Unit 6: High Voltage Testing in Electrical Apparatus.</b> Overvoltage's due to Lightning phenomenon and Switching Surges, Principles of Insulation Coordination on High Voltage power systems, Testing of Insulators and Bushings, Testing of Isolators and Circuit Breakers, Testing of Cables, Testing of Transformers and Surge Arresters.	[6]
<b>Textbooks</b> 1. M S Naidu and V Kamaraju, High Voltage Engineering, Mc Graw Hill Publishing Company Ltd.- Sixth Edition. 2. C L Wadhwa, High Voltage Engineering, New Age International Publishers, 3 <sup>rd</sup> Edition.	
<b>Reference Books:</b> 1. Subir Ray, An Introduction to High Voltage Engineering, PHI-Second Edition. 2. E Kuffel, W.S.Zaengl, J Kuffel, High Voltage Engineering Fundamentals, Newnes,-Second Edition. 3. Ravindra Arora and Wolfgang Mosch, High Voltage Insulation Engineering, New Age International Publishers	



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### Switchgear and Protection

23EE4702	PCC	Switchgear and Protection	2-0-0	2 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 2 hrs/week	CA1:10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Power System, DC and AC Machines

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Explain Circuit Breakers
CO2	Explain Protective relaying used for power system protection
CO3	Explain Digital and Numerical Protection
CO4	Select Protection schemes used for protection of Alternator and Transformer
CO5	Select Protection schemes used for protection of Bus bar, Feeder and Transmission line
CO6	Explain Insulation co-ordination and Over Voltage Protection

**Course Contents:**

<p><b>Unit 1: Circuit Interruption</b> Voltage-current characteristics of arc, Principles of circuit interruption, arc phenomenon, A.C. and D. C. circuit breaker, Restricting and recovery voltage. Arc quenching methods, current chopping. Capacitive, inductive current breaking, resistance switching, Auto reclosing</p>	[4]
<p><b>Unit 2: Circuit Breakers:</b> Construction, working and application of Air blast, Bulk oil, Minimum oil, SF6 and Vacuum circuit breakers, Circuit breaker ratings, HVDC breakers, H. R. C. fuses and its applications. Construction, working and application of MCB and MCCB</p>	[4]
<p><b>Unit 3: Protective Relaying:</b> Need of protective relaying in power system, General idea about protective zone, Primary and backup protection, Desirable qualities of protective relaying, Classification of relays, Principle of working and characteristics of attracted armature, balanced beam, induction, disc and cup type relays, induction relays, Current Setting and Time setting of Overcurrent relay, Time-current characteristics of over current Relays; directional, differential, percentage differential and distance (impedance, reactance, mho) relays, introduction to static relays</p>	[6]
<p><b>Unit 4: Digital and Numerical Protection:</b> Introduction, Advantages and Disadvantages of Numerical relays, Numerical relaying algorithms techniques Diff. methods of Digital and Numerical protection, Numerical over current protection, Numerical Distance protection, Numerical Differential protection</p>	[4]
<p><b>Unit 5: Protection of Alternators and Transformers:</b> <b>Alternators:</b> Stator fault, stator inter turn protection, Percentage differential protection system, Negative phase sequence [NPS] protection, Excitation Failure and Protection</p>	[6]



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against motoring <b>Transformer:</b> Use of Buccholz relay, differential protection, connection of C. T. and calculation of C.T. ratio needed for differential relaying, restricted earth fault protection, Frame leakage protection, Generator-Transformer unit protection	
<b>Unit 6: Protection of Bus bar, Feeder and Transmission line:</b> Bus bar protection, circulating current protection and Transmission line protection using over current relays. Principles of distance relaying, choice between impedance, reactance and mho types, pilot wire and carrier pilot protection.	[6]
<b>Textbooks /Reference Books:</b> 1. Sunil S. Rao, Switchgear Protection and Power Systems (Theory, Practice and Solved Problems), Khanna Publications. 2. B.Ram and B.N.Vishwakarma, Power System Protection and Switchgear, Tata McGraw Hill Education Private Limited, New Delhi. 3. Patara Basu and Chaudhary, Power System Protection, New Delhi Oxford and IBH. 4. L.P.Singh, <i>Digital Protection Protective Relaying from Electromechanical to Microprocess</i> , New Age International Publishers, 2 <sup>nd</sup> Edition, 2017	



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**Program Elective Course-III: Digital Control Systems**

23EE4703A	PEC	Digital Control Systems	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1:10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Control Systems.

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Understand basic concepts of Z and Laplace transform related to digital control systems.
CO2	Design of digital control system using Root locus, Controllers, compensators.
CO3	Explain state space representation and its forms.
CO4	Study state space equations, state transition matrix.
CO5	Design of controller by using Pole placement.
CO6	Design of observer by using Pole placement.

**Course Contents:**

<b>Unit 1 - Digital Control System</b> Review of Z transforms, Z transform method for solving difference equation, Impulse Sampling and Data Hold, Pulse Transfer Function, Sampling Theorem, Mapping between S Plane and Z Plane, Stability Analysis, Transient and Steady State Analysis	[6]
<b>Unit 2 - Design of Digital Control System</b> Construction of Root Locus, Design based on Root Locus, P,PI,PD,PID Controllers, Lead, Lag, Lead-Lag Compensators, Frequency Response Analysis, Bode Diagram.	[6]
<b>Unit 3 - State Space Analysis of Digital Control System I</b> State Space representation of Digital System, Controllable Canonical form, Observable Canonical form, Diagonal form, Jordan form.	[6]
<b>Unit 4- State Space Analysis of Digital Control System II</b> State Space Equations, solving State Space Equations, State Transition Matrix, Properties of State Transition Matrix, Pulse Transfer Function Matrix. Discretization of Continuous Time State Space Equation.	[6]
<b>Unit 5 - State Space Design for Controller</b> Controllability, Controller Design in State Space, Design via Pole Placement for Controller Design, Ackermann's Formula for Controller Design.	[6]
<b>Unit 6 – State space Design for Observer</b> Observability, Observer Design, Design via Pole Placement for Observer Design, Ackermann's Formula for Observer Design, Deadbeat Design, Design for Deadbeat Response.	[6]



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**Textbooks:**

1. K. Ogata, "Discrete Time Control Systems", Second Edition, Pearson Education, 2005
2. C.L. Phillips, J.M. Parr, "Feedback Control Systems", Fifth Edition, Pearson Education, 2013

**Reference Books:**

1. I.J. Nagrath, M.Gopal "Control Systems Engineering", New Age International, Sixth Edition, 2018,
2. B.C. Kuo, "Digital Control Systems", Oxford University Press, Second Edition, 2012



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**Program Elective Course-III: Switched Mode Power Supplies**

23EE4703B	PEC	Switched Mode Power Supplies	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1:10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Power Systems, Power Electronics

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Explain the working principles of different types of SMPS topologies.
CO2	Analyze DC-DC converters used in SMPS.
CO3	Evaluate control strategies for voltage regulation in SMPS.
CO4	Model SMPS circuits for performance validation.
CO5	Identify power quality and EMI issues in SMPS systems.
CO6	Analyze thermal design principles, protection mechanisms, and fault diagnostics techniques to enhance the reliability and efficiency of power supply systems.

**Course Contents:**

<b>Unit 1: Introduction to SMPS</b> Need and advantages of SMPS over linear power supplies; Classification and applications; Overview of components: inductors, transformers, MOSFETs, diodes; Efficiency and compactness benefits.	[6]
<b>Unit 2: DC-DC Converter Topologies</b> Buck, Boost, Buck-Boost converters: operating modes, waveforms, voltage/current equations; Continuous and discontinuous modes; Cuk and SEPIC converters; Design examples.	[6]
<b>Unit 3: Isolated Converters</b> Forward, Flyback, Push-Pull, Half-Bridge, Full-Bridge converters; Transformer design considerations; Core selection; Leakage inductance and snubbers; Voltage regulation techniques.	[6]
<b>Unit 4: Control of SMPS</b> Voltage mode and current mode control; Feedback loop design and compensation; PWM control techniques; Error amplifiers; Transfer function modeling and Bode plot analysis.	[6]



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<b>Unit 5: Power Quality and EMI Considerations</b> Input/output filters; Conducted and radiated EMI; EMC standards and compliance; Soft-switching techniques (ZVS, ZCS); Effect on power factor and harmonic mitigation.	[6]
<b>Unit 6: Thermal Management and Protection</b> Thermal design: heat sinks, airflow, thermal modeling; Protection mechanisms: overcurrent, overvoltage, short circuit, thermal shutdown; Fault diagnostics and isolation techniques.	[6]
<b>Textbooks:</b> 1. Rashid, M. H. – 'Power Electronics: Circuits, Devices and Applications'. Pearson. 2. Kassakian, J. G. – 'Principles of Power Electronics'. Addison Wesley. 3. Mohan, Undeland and Robbins – 'Power Electronics: Converters, Applications and Design'. Wiley.	
<b>Reference Books:</b> 1. Pressman, Abraham I. – 'Switching Power Supply Design'. McGraw-Hill. 2. Billings, Keith – 'Switchmode Power Supply Handbook'. McGraw-Hill. 3. NPTEL Course – 'Switching Power Converters'. IIT Kharagpur.	



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**Program Elective Course-III: FACTS and HVDC**

23EE4703C	PEC	FACTS and HVDC	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1:10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Power System, Power Electronics

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Classify different types of FACTS devices.
CO2	Explain the Static shunt compensators.
CO3	Explain the Static series compensators.
CO4	Explain the combined compensators.
CO5	Compare AC and DC transmission system.
CO6	Explain the control schemes for HVDC transmission systems.

**Course Contents:**

<b>Unit 1: Introduction to FACTS</b> Opportunities for FACTS, Flow of power in AC system, Basic types of FACTS Controllers, Brief description and definitions of FACTS controllers: Shunt connected controllers, Series connected controllers, Combined Shunt and Series connected controllers, Benefits from FACTS Technology	[6]
<b>Unit 2: Static shunt compensators</b> Objectives of shunt compensation, Methods of controllable VAR generation: Variable Impedance Type, Switching Converter Type, Construction and Working of : Hybrid VAR Generators, Static VAR compensators - SVC and STATCOM, Comparison between SVC and STATCOM	[6]
<b>Unit 3: Static Series Compensators:</b> Objectives of Series compensation, Construction and Working of : Thyristor switched series capacitor (TSSC), Thyristor Controlled series capacitor (TCSC), GTO Thyristor Controlled series capacitor (GCSC), Switching converter type series compensators: Static synchronous series compensator (SSSC), Power angle characteristics, Basic operating control schemes	[7]
<b>Unit 4: Combined Compensators</b> Introduction, unified power flow controller (UPFC): Basic operating principle, independent real and reactive power flow control, control structure, Unified Power Quality Conditioner (UPQC), Interline power flow controller (IPFC): Basic operating principle, control structure	[6]



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<b>Unit 5: HVDC System and Converters:</b> Comparison of AC-DC transmission systems, Benefits of DC transmission, Types of DC Links, Typical layout of HVDC converter station, Line commutated converter, Voltage source converter	[6]
<b>Unit 6: HVDC system control</b> Principles of DC Link control, converter control characteristics, system control hierarchy, firing angle control, current and excitation angle control, starting and stopping of DC Link, Generation of Harmonics, Introduction of Filters	[8]
<b>Textbooks:</b> 1. Understanding FACTS: Concepts and Technology of Flexible AC Transmission systems, Narain. G.Hingorani, Laszlo Gyugyi, IEEE press, Wiley India 2. HVDC Power transmission systems, K R Padiyar, New Age International.	
<b>Reference Books:</b> 1. Thyristor Based Controllers for Electrical Transmission Systems, R. Mohan Mathur, Rajiv K. Varma. Wiley India. 2. HVDC and FACTS Controllers applications of static converters in power systems, Vijay K. Sood, Kluwer Academic Publishers.	



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### Program Elective Course-III: Electric Vehicle Battery and Chargers

23EE4703D	PEC	EV Battery and Chargers	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1:10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** E-Mobility

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Understand the fundamentals of batteries used in electric vehicles.
CO2	Analyze battery characteristics and performance parameters.
CO3	Select and size batteries for EV applications.
CO4	Describe different types of battery management systems and charging techniques.
CO5	Design EV charging infrastructure and evaluate charging strategies.
CO6	Evaluate the safety, standards, and regulations for EV battery systems.

**Course Contents:**

<b>Unit 1: Basics of EV Batteries</b> Battery types: Li-ion, NiMH, Lead-acid; Electrochemistry; Construction and working; Battery specifications: energy density, power density, SOC, DOD, efficiency, C-rating.	[6]
<b>Unit 2: Battery Modeling and Sizing</b> Battery equivalent circuit modeling; Dynamic behaviour and thermal modeling; Sizing batteries for EV performance and range; Cell configurations (series-parallel); Lifecycle analysis.	[6]
<b>Unit 3: Battery Management Systems (BMS)</b> Functions of BMS: monitoring, balancing, protection; SOC/SOH estimation techniques; Passive and active balancing; BMS communication protocols; Safety features in BMS.	[6]
<b>Unit 4: Charging Techniques and Architectures</b> Types of charging: AC/DC, Level 1/2/3; Constant current and constant voltage charging; Fast and wireless charging techniques; On-board and off-board chargers; Converter topologies for charging.	[6]
<b>Unit 5: EV Chargers and Infrastructure</b> Charger architecture and control; Smart charging systems; Grid integration; Load management and V2G (Vehicle-to-Grid); Standards: IEC 61851, CHAdeMO, CCS, GB/T.	[6]



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<b>Unit 6: Battery Safety and Standards</b> Thermal runaway; Battery fire safety and protection; Safety testing standards (UN 38.3, ISO 26262); Recycling and disposal of EV batteries; Regulatory norms and certification.	[6]
<b>Textbooks:</b> 1. Husain, Iqbal – 'Electric and Hybrid Vehicles: Design Fundamentals'. CRC Press. 2. Linden and Reddy – 'Handbook of Batteries'. McGraw-Hill. 3. Mourad, A. – 'Battery Management Systems for Large Lithium Ion Battery Packs'. Wiley.	
<b>Reference Books</b> 1. Tuttle, D. – 'EV Charging Technology and Standards'. SAE Publications. 2. Plett, G. L. – 'Battery Management Systems, Vol. 1 and 2'. Artech House. 3. NPTEL Course – 'Battery Storage Systems for EVs'. IIT Madras.	



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**Program Elective Course-IV: Advanced Control Theory**

23EE4704A	PEC	Advanced Control Theory	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1:10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Control Systems

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Estimate State Feedback Gain Matrix and Observer Gain matrix with pole placement techniques.
CO2	Design of Lag, Lead, Lag-Lead Compensator Design Using Bode Plot and Root Locus Technique
CO3	Explain Linear Models of Physiological Systems
CO4	Analyze nonlinear system using Describing function approach and Phase plane analysis

**Course Contents:**

<p><b>UNIT-1: POLE PLACEMENT TECHNIQUE</b>            Introduction, Pole Placement Design, Necessary and Sufficient conditions for Arbitrary Pole Placement, Evaluation of State Feedback Gain Matrix-using Transformation Matrix, Direct Substitution Method, Ackermann's Formula; Concept of State Observer, Selection of suitable value of Observer Gain matrix-Numerical problems.</p>	[7]
<p><b>UNIT-2: COMPENSATORS-1:</b>            Introduction, Classification: Series or cascade compensation, Feedback or parallel compensation, Load or series-parallel compensation, State feedback compensation, Forward compensation with series compensation, Feed-forward compensation  <b>Lag Compensator:</b> Determination of Maximum Phase Angle, Electrical Representation, Effects, Limitations, Design of Lag Compensator Design Using Bode Plot, Design of Lag Compensator Using Root Locus Technique.</p>	[7]
<p><b>UNIT-3: COMPENSATORS-2:</b>  <b>Lead Compensator:</b> Determination of Maximum Phase Angle, Electrical Representation, Effects, Limitations, Design of Lead Compensator, Design of Lead Compensator Using Bode Plot, Design of Lead Compensator Using Root Locus Technique.  <b>Lag-Lead Compensator:</b> Electrical Representation, Effects, Design of Lag-Lead Compensator, Design of Lag-Lead Compensator Using Bode Plot, Design of Lag-Lead Compensator Using Bode Plot.</p>	[7]
<p><b>UNIT-4: PHYSIOLOGICAL CONTROL SYSTEMS:</b>            Introduction, Properties of Physiological Control Systems: Target of the Homeostasis, Imbalance in the Homeostasis, Homeostasis Control Mechanisms, Block Diagram of the Physiological Control System: Types of Control Mechanism, Differences between Engineering and Physiological Control Systems, Linear Models of Physiological Systems: Lung Mechanism, Skeletal Muscle</p>	[6]



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<b>UNIT-5: DESCRIBING FUNCTION ANALYSIS:</b> Introduction to nonlinear systems, Types of nonlinearities, Non Linear Systems – Types of Nonlinearities – Saturation – Dead-Zone – Backlash – Jump Phenomenon, Linearization of nonlinear systems, Singular Points and its types describing functions, describing function analysis of nonlinear control systems.	[6]
<b>UNIT-6: PHASE-PLANE ANALYSIS:</b> Introduction to phase-plane analysis, Method of Isoclines for Constructing Trajectories, singular points, phase-plane analysis of nonlinear control systems.	[6]
<b>Text/Reference Books:</b> 1. Modern Control System Theory – by M. Gopal, New Age International Publishers, 2 <sup>nd</sup> edition, 1996. 2. Control Systems Engineering by S. Salivahanan, R. Rengaraj, G.R.Venkatakrishnan, Pearson Education. 3. Modern Control Engineering – by K. Ogata, Prentice Hall of India, 3 <sup>rd</sup> edition, 1998 4. Control Systems Engineering by I.J. Nagarath and M.Gopal, New Age International (P) Ltd. 5. Modern Control Theory, U A Bakshi, M V Bakshi, Technical Publications	



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**Program Elective Course-IV: Electricity Markets**

23EE4704B	PEC	Electricity Markets	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1:10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Power Systems

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Explain the fundamentals of electricity markets, including market structures, operating mechanisms, and various market types such as commodity, power, energy, and ancillary services.
CO2	Analyze the modeling, operation, and equilibrium of electricity markets to assess the impact of market dynamics on pricing and competition.
CO3	Evaluate the formulation of market structures, price drivers, carbon markets, and the influence of renewables, seasonality, and cross-border transmission capacity on market performance.
CO4	Apply electricity pricing methodologies, including market clearing price (MCP), spot and real-time pricing, and dispatch-based pricing to optimize power flow and market efficiency.
CO5	Design effective strategies for power system operation in restructured markets, addressing congestion management, imbalance settlement, and transmission constraints through dynamic methodologies.
CO6	Assess the significance of ancillary services in electricity markets, including contingency reserves, voltage security, and procurement mechanisms across various market structures.

**Course Contents:**

<b>UNIT-1:</b> Fundamentals of electricity markets: Market structure and operating mechanisms, bilateral and multi-lateral markets. Perfect Competition, Oligopolistic Market, Theories of Oligopoly. Market Types- Commodity, Power, Energy, Ancillary Services, Transmission.	[6]
<b>UNIT-2:</b> Modelling, operation and analysis of electricity markets, Market Equilibrium.	[6]
<b>UNIT-3:</b> Market Structure: Formulation of the market, Price formulation and drivers, Merit order, Carbon markets (emission rights), Impact of renewables, Mean reversion and Seasonality, Cross-border transmission capacity, Market participants (producers, suppliers, TSOs), Exchange members, Dispatch and asset-backed trading, Balancing, Intraday / prompt markets, Market coupling, Day ahead markets and Daily auctions, Hedging, Forward markets and the application of power futures.	[6]
<b>UNIT-4:</b> Electricity Markets Pricing: Electricity price basics, Market Clearing price (MCP), Zonal and locational MCPs. Dynamic, spot pricing and real time pricing, Dispatch based pricing, Power flows and prices. Optimal power flow, Spot prices for real and reactive power. Unconstrained real spot prices, constrains and real spot prices.	[6]



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<p><b>UNIT-5:</b> Power system operation in restructured markets: Coordinated real time dispatch through balancing mechanism, Imbalance settlement methodologies. Transmission Congestion Management and Methodologies, Congestion Pricing, Effect of congestion on LMPs, Transmission Losses, Limits and Congestion, Country Practices, Dynamic Congestion Management. Available Transfer Capability Evaluation and Methodologies- market splitting, counter-trading. New Unit Commitment-Price based OPF in restructured markets.</p>	[6]
<p><b>UNIT-6:</b> Ancillary Services: Classifications and definitions, Market for AS, AS management in various markets, Forward AS auction, country practices, Contingency reserves: Pricing and procurement, Voltage security and reactive power management.</p>	[6]
<p><b>Text/Reference Books:</b></p> <ol style="list-style-type: none"><li>1. M. Shahidepour, H. Yamin, and L. Zuyi, "Market Operations in Electric Power Systems". New York: Wiley, 2002.</li><li>2. Yong-Hua Song and Xi-Fan Wang (Eds.), "Operation of Market-oriented Power Systems", Springer-Verlag London Limited, 2003</li><li>3. D. S. Kirschen and G. Strbac, "Fundamentals of power system economics", John Wiley and Sons, 2004</li><li>4. K. Bhattacharya, M.H.J. Bollen and J.E. Daalder, "Operation of restructured power systems", Kluwer Academic Publishers, 2001.</li></ol>	



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**Program Elective Course-IV: Power System Reliability**

23EE4704C	PEC	Power System Reliability	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1:10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Power Systems

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Explain fundamental concepts of probability theory, including probability distributions, density functions, and reliability measures such as Mean Time to Failure (MTTF) and Mean Time Between Failures (MTBF).
CO2	Analyze generating system reliability through capacity outage probability tables, recursive model building, and loss of load and energy indices to assess system performance.
CO3	Evaluate operating reserve methodologies, including risk indices, PJM methods, and security function approaches, to determine power system stability and reliability.
CO4	Apply interconnected system reliability analysis techniques, including probability array methods, effects of tie capacity, and Markov models, to improve system resilience.
CO5	Assess distribution system reliability by evaluating performance indices, customer-oriented metrics, and energy loss indices for effective system planning and operation.
CO6	Design strategies for substation and switching station reliability, incorporating preventive maintenance, circuit breaker models, and short-circuit failure analysis for enhanced system reliability.

**Course Contents:**

<p><b>UNIT-1: BASIC PROBABILITY THEORY:</b> Elements of probability, probability distributions, Random variables, Density and Distribution functions- Binomial distribution- Expected value and standard deviation - Binomial distribution, Poisson Distribution, normal distribution, exponential distribution.</p> <p><b>DEFINITION OF RELIABILITY:</b> Definition of terms used in reliability, Component reliability, Hazard rate, derivation of the reliability function in terms of the hazard rate. Hazard models - Bath tub curve, Effect of preventive maintenance. Measures of reliability: Mean Time to Failure and Mean Time between Failures.</p>	[6]
<p><b>UNIT-2: GENERATING SYSTEM RELIABILITY ANALYSIS</b> Generation system model – capacity outage probability tables – Recursive relation for capacitive model building – sequential addition method – unit removal – Evaluation of loss of load and energy indices – Examples. Frequency and Duration methods – Evaluation of equivalent transitional rates of identical and non-identical units – Evaluation of cumulative probability and cumulative frequency of non-identical generating units</p>	[6]
<p><b>UNIT-3: OPERATING RESERVE EVALUATION</b> Basic concepts - risk indices – PJM methods – security function approach – rapid start and hot reserve units – Modeling using STPM approach.</p> <p><b>BULK POWER SYSTEM RELIABILITY EVALUATION:</b> Basic configuration – conditional probability approach – system and load point reliability indices – weather effects</p>	[6]



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on transmission lines – Weighted average rate and Markov model – Common mode failures.	
<b>UNIT-4: INTER CONNECTED SYSTEM RELIABILITY ANALYSIS:</b> Probability array method – Two inter connected systems with independent loads – effects of limited and unlimited tie capacity - imperfect tie – Two connected Systems with correlated loads – Expression for cumulative probability and cumulative frequency	[6]
<b>UNIT-5: DISTRIBUTION SYSTEM RELIABILITY ANALYSIS</b> Basic Techniques – Radial networks –Evaluation of Basic reliability indices, performance indices – load point and system reliability indices – customer oriented, loss and energy oriented indices – Examples.	[6]
<b>UNIT-6: SUBSTATIONS AND SWITCHING STATIONS</b> Effects of short-circuits - breaker operation – Open and Short-circuit failures – Active and Passive failures – switching after faults – circuit breaker model – preventive maintenance – exponential Maintenance times.	[6]
<b>Textbooks:</b> 1. Reliability Evaluation of Power systems by R. Billinton, R.N.Allan, BS Publications, 2007. 2. Reliability Modeling in Electric Power Systems by J. Endrenyi, John Wiley and Sons, 1978 <b>Reference Books:</b> 1. Reliability Engineering: Theory and Practice by Alessandro Birolini, Springer Publications. 2. An Introduction to Reliability and Maintainability Engineering by Charles Ebeling, TMH Publications. 3. Reliability Engineering by E. Balaguruswamy, TMH Publications. 4. Reliability Engineering by Elsayed A. Elsayed, Prentice Hall Publications.	



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**Program Elective Course-IV: Electric Vehicles: Design, Dynamics and Testing**

23EE4704D	PEC	Electric Vehicles: Design, Dynamics and Testing	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** E-Mobility, EV Battery and Chargers

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Analyze the effects of body loads, material selection, and manufacturing criteria on the design and structural integrity of electric vehicle chassis.
CO2	Evaluate vehicle dynamics and stability parameters, including tyre properties, aerodynamic forces, and load distribution, to enhance control and performance.
CO3	Apply homologation and testing standards to ensure compliance with safety regulations and performance benchmarks for electric vehicles.
CO4	Assess the testing methodologies for hybrid electric vehicles and retro-fitment, focusing on battery performance, regenerative braking, and type approvals.
CO5	Interpret vehicular safety regulations, government policies, and road safety systems to ensure adherence to industry norms and occupant protection.
CO6	Design efficient EV infrastructure solutions, including battery management systems, swapping mechanisms, and charging station networks, for sustainable adoption.

**Course Contents:**

<p><b>Unit-1: Design and Manufacturing Criteria:</b></p> <p>Introduction to body loads: Load cases and load factor, road loads. Driving dynamics and comfort, strength and stiffness of chassis, design features, frame sections, types of frames. Material selection, Fabrication, joining methods, types of joints, welding and brazing, pierce riveting and clinching.</p>	[6]
<p><b>Unit-2: Vehicle Dynamics and Stability:</b></p> <p>Wheels and Tyres: Introduction, Types of wheel rims, wheel dimension, properties of tyre, construction, Tread patterns, Types of tyres, Specifications of tyre. Drag, lifts, resistance, body loads and load calculation, Study principles of Rolling, Pitch and Yaw velocity and moments, aesthetics and ergonomics consideration for stability and control.</p>	[6]
<p><b>Unit-3: Vehicle Testing and Homologation:</b> Need of vehicle testing and homologation, testing organizations, testing standards (AIS), Hierarchy of testing: Individual component approval/testing, System level approval and Whole vehicle approval/testing. Conformity of production tests, Crash test, side impact test, rollover test, Impact test, Track testing</p>	[6]



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<b>Unit-4: Testing Standards For Hybrid Electric vehicle and Retro-fitment</b> Method for Measuring the Electricity Balance of the Battery of OVC and NOVC HEVS. CMVR Type Approval for L Category Hybrid Electric Vehicles: types of test and conditions, Requirements for Regenerative Braking System, Method of Measuring the Electric Range of Vehicles Powered by A Hybrid Electric Power Train. CMVR Type Approval for Hybrid Electric Vehicles of M and N Category: Related terms, types of tests, requirements. Retrofitment standards on Vehicles of L, M and N Category having different weight criteria, types of test and procedures.	[6]
<b>Unit-5: Vehicular Safety and Government norms:</b> Road and Automotive Safety Systems: Active and passive safety, Safety Regulations for vehicular application, occupant protection, Traffic signs, traffic rules. Government Norms, Regulations and Policies: Motor vehicle act: control of transport, RTO and other regulations, offences, penalties and procedures.	[6]
<b>Unit-6: EV Infrastructure Management:</b> Comparison between EV and ICE vehicles, Battery management system, Battery swapping, vehicle charging system, Charging stations.	[6]
<b>Text/Reference Books:</b> <ol style="list-style-type: none"><li>1. Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, Ali Emadi (2005),</li><li>2. Modern Electric, Hybrid Electric, and Fuel cell vehicles, Fundamentals, Theory, and Design” CRC Press.</li><li>3. Chan, C.C. and Chau, K.T., “Modern Electric Vehicle Technology,” Oxford University Press, 2001.</li><li>4. Das, Shuvra, “Modeling for Hybrid and Electric Vehicles Using Simscape,” Springer, 2021.</li><li>5. Du, H., Cao, D., Zhang, H., “Modeling, Dynamics, and Control of Electrified Vehicles,” Woodhead Publishing, 2017.</li><li>6. Scrosati, B., Garche, J., Tillmetz, W., “Advances in Battery Technologies for Electric Vehicles,” Woodhead Publishing, 2015.</li><li>7. Guiggiani, M., "The Science of Vehicle Dynamics: Handling, Braking, and Ride of Road and Race Cars," Springer, 2018.</li><li>8. Thomas D. Gillespie, Fundamentals of Vehicle Dynamics, Society of Automotive Engineers.</li><li>9. Donald E. Malen, Fundamentals of Automobile Body Structure Design, SAE International</li><li>10. P.S.Gill, A Textbook of Automobile Engineering-II, S.K.Kataria and Sons.</li></ol>	



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### Research Methodology

23EE4705	RM	Research Methodology	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1: 10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** E-Mobility, EV Battery and Chargers

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Describe fundamental concepts of research, including the characteristics of good research, research problems, hypotheses, and the importance of reviewing literature to develop a strong research foundation.
CO2	Distinguish various types of research, including basic and applied, qualitative and quantitative, while examining research designs such as exploratory, descriptive, and causal methodologies to determine their appropriate applications.
CO3	Apply appropriate sampling techniques, data collection methods, and statistical analysis tools to classify and visually represent research data for meaningful insights.
CO4	Organize research reports, journal articles, abstracts, theses, and bibliographies while following academic writing standards for clarity and accuracy.
CO5	Evaluate ethical considerations in research, including plagiarism, copyright infringement, collaborative work, and the essential qualities of a responsible researcher.
CO6	Utilize ICT tools such as Mendeley, Endnote, statistical software, and web search engines to effectively manage research data and enhance the research process.

**Course Contents:**

<b>Unit-1: Introduction to Research:</b> The concept of research, characteristics of good research, Application of Research, Meaning and sources of Research problem, characteristics of good Research problem, Research process, outcomes, application of Research, Meaning and types of Research hypothesis, Importance of Review of Literature, Organizing the Review of Literature.	[6]
<b>Unit-2: Types of Research:</b> Types of research, pure (basic, fundamental) and applied research, qualitative and quantitative. Research Design: Meaning, need, types of research design – Exploratory, Descriptive, Casual research Design, Components of research design, and Features of good Research design. Experiments, surveys and case study Research design.	[6]
<b>Unit-3: Sampling, Data Collection and analysis:</b> Types and sources of data – Primary and secondary, Methods of collecting data, Concept of sampling and sampling methods – sampling frame, sample, characteristics of good sample, simple random sampling, purposive sampling, convenience sampling, snowball sampling, classification and tabulation of data, graphical representation of data, graphs and charts – Histograms, frequency polygon and frequency curves, bell shaped curve and its properties. Statistical Methods for Data Analysis : Applications of Statistics in Research, measures of central tendency and dispersion	[6]



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<b>Unit-4: Research Report:</b> Research report and its structure, journal articles – Components of journal article. Explanation of various components. Structure of an abstract and keywords. Thesis and dissertations, components of thesis and dissertations. Referencing styles and bibliography.	[6]
<b>Unit-5: Ethics in Research</b> - Plagiarism - Definition, different forms, consequences, unintentional plagiarism, copyright infringement, collaborative work. Qualities of good Researcher.	[6]
<b>Unit-6: ICT Tools for Research:</b> Role of computers in research, maintenance of data using software such as Mendeley, Endnote, Tabulation and graphical presentation of research data and software tools. Web search: Introduction to Internet, use of Internet and WWW, using search engines and advanced search tools.	[6]
<b>Textbooks/Reference Books:</b> <ol style="list-style-type: none"><li>1. Donald Cooper and PS Schindler, Business Research Methods, 9<sup>th</sup> edition, Tata McGraw Hill, 2009.</li><li>2. Kothari C. R Research Methodology,</li><li>3. Uma Sekaran, Research Methods for Business, 4<sup>th</sup>edition, Wiley, 2010.</li><li>4. Ranjit Kumar, Research Methodology, 2<sup>nd</sup>edition, Pearson Education, 2009.</li><li>5. Naresh Malhotra and S Dash, Marketing Research, 5<sup>th</sup>edition, Pearson Prentice Hall, 2009.</li></ol>	



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**High Voltage Engineering Laboratory**

23EE4706	PCC	High Voltage Engineering Laboratory	0-0-2	1 Credit
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Teaching Scheme	Evaluation Scheme
Practical: 2 hrs/week	CA1:15 Marks CA2: 15 Marks End Semester Exam: 20 Marks

**Pre-Requisites:** Basic Electrical Engineering, Electrical Engineering Materials, Power System

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Determine dielectric high voltages withstand capability of gaseous medium.
CO2	Determine dielectric high voltages withstand capability of liquid medium.
CO3	Determine dielectric high voltages withstand capability of solid medium.

**Course Contents:**

**List of Experiments:** Any 8 from below mentioned experiment list

1. To demonstrate Horn Gap arrangement as surge diverter for corona arc discharge.
2. To measure audible sound in db and visible temperature using Thermal Imaging Camera in Faraday's cage arrangement.
3. To determine the effect of gap length on breakdown strength of liquid insulating Material (Transformer Oil).
4. To measure High Voltage Withstand capability of cables at DC Voltages (Max up to 10KV).
5. To determine Breakdown Voltage for Solid Composite Insulating Materials (30KV, 30mA test setup with jig).
6. To measure High Voltage with-stand capability of cables at Power Frequency AC Voltages (Max up to 30KV).
7. To demonstrate development of Tracks and Trees of polymeric insulation.
8. To determine the effect of change in gap length over breakdown voltage in the air medium using sphere gap assembly.
9. To study Impulse voltage generator using Virtual Laboratory.
10. Visit to High Voltage Laboratory and to generate report over Layout and Components of High Voltage Laboratory.



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### Switchgear and Protection Laboratory

23EE4707	PCC	Switchgear and Protection Laboratory	0-0-2	1 Credit
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Teaching Scheme	Evaluation Scheme
Practical: 2 hrs/week	CA1: 15 Marks CA2: 15 Marks End Semester Evaluation: 20 Marks

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Select overcurrent relay for different applications.
CO2	Explain microprocessor based impedance relay.
CO3	Demonstrate Power system protection equipment's.

**Course Contents:**

**List of Experiments:**

1. Experimental study of working of electromechanical overcurrent relay.
2. Experimental study of working of a Directional overcurrent relay.
3. Experimental realization of microprocessor based overcurrent relay.
4. Experimental study of working of microprocessor based impedance relay.
5. Demonstration of LT Switchgear by Industrial visit
6. Demonstration of operation of protection systems for Feeder, Transmission lines by Industrial visits
7. Study of Transformer protection system in substation by Industrial visits.
8. Study of Generator protection system by field visit.
9. Study of Substation equipment's in power system by field system.



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**Mega Project Phase-II**

23EE4708	PROJ	Mega Project Phase-II	0-0-4	2 Credits
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Teaching Scheme	Evaluation Scheme
Practical: 4 hrs/week	CA1:25 Marks CA2: 25 Marks End Semester Exam: 50 Marks

**Pre-Requisites:**

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Build an engineering project.
CO2	Discuss with engineers and the community at large in written and oral forms.
CO3	Demonstrate the knowledge, skills and attitudes of a professional engineer.

Since Mega Project Phase-II is in continuation to Mega Project Phase-I, the students are expected to complete the total project by the end of semester VII. After completion of project work, they are expected to submit the project report including the work done in Phase-I and Phase-II.

The report shall be comprehensive and presented typed on A4 size sheets and **hard bound**. The number of copies to be submitted is number of students plus two. The assessment would be carried out by the panel of examiners (Guide and Project Evaluation Members) for both, term work and oral Evaluations.

The project work should be published in any one of the national/international quality conference or reputed journal.

Report shall summarize the literature survey; spell out the scope of work, methodology and results. Viva-voce Evaluation shall be based on work carried out by the student.



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**Seminar**

23EE4709	RM	Seminar	0-0-2	1 Credit
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Teaching Scheme	Evaluation Scheme
Practical: 2 hrs/week	End Semester Exam: 50 Marks

**Pre-Requisites:**

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Identify and select relevant seminar topics based on the syllabus, while conducting a thorough literature review to establish a strong research foundation.
CO2	Analyze state-of-the-art methodologies, including simulation, experimentation, mathematical modeling, and analysis, to determine their applicability to the chosen topic.
CO3	Formulate a problem statement and define the methodology, scope, and objectives to ensure a structured approach toward achieving result-oriented solutions.
CO4	Evaluate quantified results and present concluding remarks that align with predefined objectives, while effectively communicating findings through a final report and presentation.

**Guidelines for Seminar Conduction:**

The evaluation of the seminar report is proposed with the following stages.

**Stage-I**

In this stage the student is expected to deliver the following:

1. Topic selection (based on the syllabus of this course)
2. Literature review
3. State of the art related to the topic of interest (Simulation/Experimentation/Mathematical modeling/analysis, etc.)

**Stage-II**

1. Problem statement (It must be result oriented solution for specific issues)
2. Methodology
3. Scope and objectives

**Stage-III**

1. Quantification of results
2. Concluding remarks or summary (must be relevant to the specified objectives)

**Stage-IV**

1. Final report
2. Final presentation/viva

The group has to make a presentation in front of the faculty of department at the end of semester. During end semester examination Internal examiner (preferably the guide) and External examiners jointly, evaluate the project work. During the process of monitoring and CA and evaluation the individual performance is to be measured. The seminar term work shall be evaluated on the basis of reviews. The final presentation shall be taken in front of external examiner and to be evaluated for 50 marks.



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### **Contents of the Seminar report**

The contents of the seminar report as mentioned in section-3 are expected to include the following:

- Abstract/Summary
- Introduction: Scope and Methodology
- Literature review: The review should be conducted from at least 10/15 reputed / renowned research papers published during last five years.
- Case study
- References

### **Instructions for seminar report writing:**

It is important that the procedures listed below be carefully followed by all the students.

1. Prepare two spiral bound copies of your Seminar report.
2. Limit your seminar report to preferably 20 to 25 pages only.
3. Header for e.g. Title of the seminar- right aligned
4. The footer for e.g. page numbers-right aligned
5. Dept. of EE, SITCOE-left aligned.
6. The report shall be prepared using Latex preferably (default font throughout) with double spacing throughout on A4 page.

Page	Left margin	Right margin	Top margin	Bottom margin
A-4 (8.5×11 inch)	1.5"	1"	1"	1"

7. Section titles should be bold typed in all capital letters and should be left aligned.
8. Sub-Section headings should be aligning at the left, bold and Title Case (the first letter of each word is to be capitalized).
9. Figure No. at bottom and Title at top with 10 pt; Legends below the title in 10 pt.
10. Please use SI system of units only.
11. References should be either in order as they appear in the report or in alphabetical order.



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**Multidisciplinary Minor -V: Earthing Design**

23EEMDA5	MDM	Earthing Design	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1:10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Electrical System Planning and Design, Electrical Estimation and Costing, Lighting System Design, Industrial System Design

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Explain the fundamental principles and objectives of earthing systems.
CO2	Analyze soil resistivity and grounding resistance measurements.
CO3	Design grounding systems in substations and industries as per IEEE/IS standards.
CO4	Evaluate the effectiveness of lightning and surge protection systems.
CO5	Simulate and validate earthing systems using engineering software.
CO6	Comply with safety regulations and interpret simulation results.

**Course Contents:**

<b>Unit-1: Introduction to Grounding</b> Purpose and need for earthing; Types of grounding systems: system and equipment; Earth potential and safety; Soil resistivity and its measurement using Wenner and Schlumberger methods; Impact of soil parameters on design.	[6]
<b>Unit-2: Design of Earthing Electrodes</b> Types of earth electrodes: pipe, plate, rod, strip; Factors affecting electrode resistance; Depth, spacing, backfill materials; IS 3043 and IEEE 80 design guidelines; Resistance calculations for parallel electrodes.	[6]
<b>Unit-3: Ground Resistance Measurement Techniques</b> Measurement techniques: Fall-of-potential method, 62% rule, Slope method, Clamp-on method; Earth tester working principle; Interference effects and mitigation techniques; Safety considerations.	[6]
<b>Unit-4: Substation and Industrial Earthing Design</b> Grid design principles; Step and touch potentials; Earthing conductor sizing; Earthing of transformers, circuit breakers, GIS, control panels; Special design considerations in EHV substations.	[6]



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<b>Unit-5: Lightning and Surge Protection Grounding</b> Lightning basics and risk assessment; Lightning protection zones; Surge protection devices (SPD); Earthing for masts, down conductors, and shield wires; Coordination with functional earthing.	[6]
<b>Unit-6: Software Tools and Case Studies</b> ETAP, CYME, NEPLAN modules for earthing analysis; Simulation of mesh voltage, ground potential rise, current dissipation; Real-world substation case studies; Design validation and reports.	[6]
<b>Textbooks:</b>  <ol style="list-style-type: none"><li>1. Gupta, J. B. 'A Course in Electrical Installation Estimating and Costing'. S. K. Kataria and Sons.</li><li>2. IEEE Std 80-2013 – 'Guide for Safety in AC Substation Grounding'.</li><li>3. Kothari, D.P. 'Electric Power Systems'. Tata McGraw-Hill.</li></ol>	
<b>Reference Books:</b>  <ol style="list-style-type: none"><li>1. IEC 60364 – 'Electrical Installations for Buildings'.</li><li>2. Ramasamy Natarajan – 'Switchgear and Protection'.</li><li>3. ETAP User Manual – 'Ground Grid Module Guide'.</li></ol>	



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**Multidisciplinary Minor -V: IoT Implementation and Practical Applications**

23EEMDB5	MDM	IoT Implementation and Practical Applications	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1:10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** Introduction to Internet of Things

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Describe the architecture and fundamental components of IoT systems.
CO2	Compare various IoT communication protocols and their application suitability.
CO3	Interface sensors and actuators with microcontrollers for data acquisition.
CO4	Design and implement IoT applications using open-source platforms.
CO5	Evaluate IoT security risks and propose mitigation techniques.
CO6	Deploy real-time IoT systems with efficient data communication and monitoring.

**Course Contents:**

<b>Unit-1: IoT Fundamentals</b> Definition and evolution of IoT; Architecture layers – perception, network, application; IoT ecosystems and platforms; Role of embedded systems and cyber-physical systems; Edge, fog, and cloud computing paradigms.	[6]
<b>Unit-2: IoT Communication Protocols</b> Application layer protocols: MQTT, CoAP, HTTP, AMQP; Transport and network layer protocols: TCP, UDP, IPv4/IPv6; Wireless technologies: WiFi, BLE, Zigbee, LoRa, NB-IoT; Protocol stack comparisons and use-cases.	[6]
<b>Unit-3: Sensors, Actuators, and Hardware Platforms</b> Types of sensors and actuators; Interfacing using GPIO, ADC, PWM; Hardware platforms: NodeMCU, ESP32, Raspberry Pi, Arduino; I2C and SPI communication; Power management in IoT devices.	[6]
<b>Unit-4: IoT Platforms and Cloud Integration</b> Overview of IoT platforms: ThingSpeak, Blynk, Firebase, ThingsBoard; Real-time data visualization; Cloud integration using REST APIs; Device-to-cloud and cloud-to-device communication; Dashboard design.	[6]



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<b>Unit-5: Practical Applications of IoT</b> Smart home automation, Smart agriculture, Industrial IoT (IIoT); Wearables and health monitoring; GPS-based asset tracking; Real-time sensor data logging; End-to-end project implementation examples.	[6]
<b>Unit-6: Security and Deployment in IoT</b> IoT security challenges: eavesdropping, data tampering, device hijacking; Authentication and encryption (TLS, OAuth); Secure firmware updates; Over-the-air (OTA) updates; Secure deployment strategies.	[6]
<b>Textbooks:</b> <ol style="list-style-type: none"><li>1. Vijay Madiseti and Arshdeep Bahga – 'Internet of Things: A Hands-On Approach'.</li><li>2. Raj Kamal – 'Internet of Things: Architecture and Design'. McGraw-Hill.</li><li>3. Jeeva Jose – 'Internet of Things'. Khanna Publishing House.</li></ol>	
<b>Reference Books:</b> <ol style="list-style-type: none"><li>1. Pethuru Raj and Anupama C. Raman – 'Architecting the Internet of Things'. Wiley.</li><li>2. Donald Norris – 'The Internet of Things: Do-It-Yourself Projects'. McGraw-Hill.</li><li>3. Marco Schwartz – 'Internet of Things Projects with ESP32'. Packt Publishing.</li></ol>	



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### Multidisciplinary Minor -V: Power Quality Improvement

23EEMDC5	MDM	Power Quality Improvement	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: 3 hrs/week	CA1:10 Marks CA2: 10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Pre-Requisites:** --

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Define and classify different power quality issues based on standards.
CO2	Analyze the causes and effects of voltage disturbances and harmonics.
CO3	Evaluate the performance of passive and active filtering solutions.
CO4	Design power quality improvement schemes using custom power devices.
CO5	Simulate and assess power quality disturbances using software tools.
CO6	Interpret measurement data and suggest appropriate mitigation techniques.

**Course Contents:**

<b>Unit-1: Introduction to Power Quality</b> Definition and scope of power quality; Power quality indices; Causes and classification of disturbances; Standards: IEEE 519, IEC 61000; Economic impact of poor power quality; Overview of power quality events.	[6]
<b>Unit-2: Voltage Disturbances</b> Types of disturbances: sags, swells, interruptions, flicker; Voltage imbalance; Sources and effects on equipment; Motor derating; Detection and characterization methods; Power quality monitors.	[6]
<b>Unit-3: Harmonics and Their Analysis</b> Harmonic generation from nonlinear loads; Fourier analysis and THD; Effects on transformers, motors, and capacitors; IEEE limits; Resonance in power systems; Harmonic spectrum and measurement tools.	[6]
<b>Unit-4: Filter Design for Harmonics</b> Passive filters: series and shunt; Design and tuning; Active power filters: shunt, series and hybrid; Compensation strategies; Real-time control of filters; Comparison and case-based selection.	[6]



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<b>Unit-5: Custom Power Devices for PQ Improvement</b> DVR: working, configuration and control; DSTATCOM: reactive power injection and voltage stabilization; UPQC: dual compensation strategy; Modeling and simulations; Installation considerations.	[6]
<b>Unit-6: Simulation and Case Studies</b> Using MATLAB/Simulink, ETAP or PSCAD for PQ simulation; Harmonic source modeling; Effectiveness of filtering solutions; Voltage sag mitigation analysis; Industry-specific case studies.	[6]
<b>Textbooks:</b> <ol style="list-style-type: none"><li>1. Arindam Ghosh and Gerard Ledwich – 'Power Quality Enhancement Using Custom Power Devices'. Springer.</li><li>2. Roger C. Dugan et al. – 'Electrical Power Systems Quality'. McGraw-Hill.</li><li>3. Math H. Bollen – 'Understanding Power Quality Problems'. IEEE Press.</li></ol>	
<b>Reference Books:</b> <ol style="list-style-type: none"><li>1. IEEE Std 519-2014 – 'Harmonic Control in Electric Power Systems'.</li><li>2. Ewald F. Fuchs and Mohammad A.S. Masoum – 'Power Quality in Power Systems and Electrical Machines'. Elsevier.</li><li>3. Bhim Singh – 'Power Quality: Problems and Mitigation Techniques'. PHI Learning.</li></ol>	



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## **Teaching and Evaluation Scheme for Final Year B. Tech**

**Department of Electrical Engineering**  
**Semester: VIII**





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**Department:** Electrical Engineering

**Rev:** Course Structure/00/2023-24

**Class:** Final Year B. Tech

**Semester:** VIII

Course Code	Course Type	Course	Teaching Scheme				Evaluation Scheme					Credits
			L	T	P	Total Hrs	CA1	CA2	MSE	ESE	Total	
23EE4801	HSSM	Self-Learning Course-1	3	-	-	3	10	10	30	50	100	3
23EE4802	PEC	Self-Learning Course-2	3	-	-	3	10	10	30	50	100	3
23EE4803	PROJ	Internship	-	-	20	20	50	50	-	100	200	10
<b>Total</b>			<b>6</b>	<b>-</b>	<b>20</b>	<b>26</b>	<b>70</b>	<b>70</b>	<b>60</b>	<b>200</b>	<b>400</b>	<b>16</b>

Self-Learning Course-1		Self-Learning Course-2	
A	Foundations of Accounting and Finance	A	Introduction to Embedded System Design
B	Financial Management for Managers	B	Cloud Computing
C	Principles of Management	C	Smart Grid: Basics to Advanced Technologies
D	Financial Accounting	D	Operations and Planning of Power Distribution Systems



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**Self-Learning Course-1: Foundations of Accounting and Finance**

23EE4801A	HSSM	Foundations of Accounting and Finance	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: NA	CA1 :10 Marks CA2 :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Course Contents:**

<p><b>Week 1:</b> Conceptual Basis of Financial Accounting, Concepts and Interactions of Financial Statements, Terminologies in Financial Accounting</p>
<p><b>Week 2:</b> Financial Statements: Balance sheet, Financial Statements: Income Statement, Financial Statements: Cash flow Statement</p>
<p><b>Week 3:</b> Financial Statement Analysis, Reading financial statements, Financial Ratios</p>
<p><b>Week 4:</b> Conceptual basis of Cost Accounting, Cost behavior, Elements of cost and preparation of cost statement, Cost Classification, Direct and Indirect cost, Overhead allocation / absorption, Traditional Method, Primary and Secondary Distribution, Activity Based Costing</p>
<p><b>Week 5:</b> Cost-Volume-Profit Analysis, Contribution Margin, Break-Even Point, Marginal Costing, Operating Leverage, Decision making using Marginal Costing</p>
<p><b>Week 6:</b> Performance Evaluation, Budgeting, Flexible Budget, Production Budget, Sales Budget Master Budget, Variance Analysis</p>
<p><b>Week 7:</b> Introduction to Corporate Finance, Time Value of Money, Discounted Cash Flows</p>
<p><b>Week 8:</b> Valuing Bonds, Valuation of Stocks as Investments,</p>
<p><b>Week 9:</b> Valuing Projects NPV and IRR, Valuing Projects Risk Analysis</p>
<p><b>Week 10:</b> Risk, Return and the Capital Asset Pricing Model</p>
<p><b>Week 11:</b> Cost of Debt, Equity, WACC, Capital Budgeting, Capital Market Efficiency, Capital Structure and Cost of Capital</p>
<p><b>Week 12:</b> Dividends and other Payouts, Course Summary</p>
<p><b>Textbooks/ Reference Books:</b></p> <ol style="list-style-type: none"> <li>1. Accounting: Text and Cases; Robert N Anthony, David F Hawkins and Kenneth A Merchant, McGraw Hill Education.</li> <li>2. Cost Accounting; Horngren, Foster and Dattar; PHI Publication</li> <li>3. Corporate Finance by Ross, Westerfield, Jaffe, Jordan and Kakani, McGraw Hill Education</li> </ol>



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**Self-Learning Course-1: Financial Management For Managers**

23EE4801B	HSSM	Financial Management For Managers	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: NA	CA1 :10 Marks CA2 :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Course Contents:**

<p><b>Week 1:</b> Financial management-an overview, Financial decisions in the firms, the fundamental principles of finance, goals of financial management, building blocks of modern finance.</p>
<p><b>Week 2:</b> Risk-return trade off, Organization of finance functions, Emerging role of financial managers' in India, Over view of financial statements – Income statement, Balance Sheet, Cash flow statement, Analysis of financial statements</p>
<p><b>Week 3:</b> Financial Planning and forecasting, Tools and techniques of Financial Planning and Forecasting, Sources of finance.</p>
<p><b>Week 4:</b> Time Value of Money, Future value of a single amount, Present value of a single amount, Future value of Annuity, Present value of Annuity and Perpetuity.</p>
<p><b>Week 5:</b> Capital Budgeting –Concept and overview, Capital budgeting process, Project classification, Techniques of capital budgeting, Investment criteria</p>
<p><b>Week 6:</b> Net present value, internal rate of return, Modified Internal rate of return, Benefit cost ratio, Pay-back period method.</p>
<p><b>Week 7:</b> Accounting rate of return, Investment appraisal in practice, Estimation of project cash flows – overview, Estimation of project cash flows-tools and techniques, Estimation of project cash flows-tools and techniques</p>
<p><b>Week 8:</b> Accounting rate of return, Investment appraisal in practice, Estimation of project cash flows – overview, Estimation of project cash flows-tools and techniques, Estimation of project cash flows-tools and techniques.</p>
<p><b>Week 9:</b> Break-even analysis, some other models and tools of risk analysis, Project selection under risk, cost of Capital-Overview, Cost of debt and preference capital.</p>
<p><b>Week 10:</b> Cost of equity, Determining the proportions, WACC, WA Marginal cost of capital, Determining the optimum capital budget.</p>
<p><b>Week 11:</b> Capital structure of firms-An overview, Net income approach, Net operating income approach, Traditional proposition, MM Proposition.</p>



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**Week 12:**

Dividend decisions-An overview, Relevance of dividend, Dividend policy formulation, Dimensions of dividend policy, Legal and procedural aspects of dividend decisions.

**Textbooks/Reference Books:**

1. Prasanna Chandra “Financial Management: Theory and Practice” 9th Edition, McGraw Hill Education Publishers.
2. Van Horne, J.C, “Fundamentals of Financial Management”, 13th Edition, Prentice Hall Publishers.
3. Brealey and Myers,” Principles of Corporate Finance”, 11th Edition, McGraw Hill Education Publishers
4. Pandey I.M., “Financial Management”, 11th Edition, Vikas Publishers.
5. Khan, M.Y. and Jain, P.K., “Financial Management”, 7th Edition, McGraw-Hill Education Publishers.



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**Self-Learning Course-1: Principles of Management**

23EE4801C	HSSM	Principles of Management	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: NA	CA1 :10 Marks CA2 :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Course Contents:**

<p><b>Week 1:</b> Introduction to Management: Management – An Emerging Profession, Definition, Nature, Scope, Purpose, and characteristics of Management, Functions, roles, skills of an effective Manager.</p>
<p><b>Week 2:</b> Evolution of Management Thought : Classical Theory, Scientific Management , Management Process or Administrative Management, Bureaucracy, Behavioral Science Approach, Quantitative Approach, Systems Approach, Contingency Approach, Operational Approach</p>
<p><b>Week 3:</b> Planning: Types of Plans, Planning Process, Introduction to Strategic Management, Types of Strategies, Understanding environment of business: Environmental appraisal – Industry Analysis - Porter’s Model of competitive advantage, analysis of organizational resources and capabilities</p>
<p><b>Week 4:</b> Forecasting and Premising : Introduction to Forecasting, Essential Components in Business Forecasting, Determinants of Business Forecasts, Benefits of Forecasting, Techniques of Forecasting, Limitations of Forecasting</p>
<p><b>Week 5:</b> Decision-making: Introduction, Components of Decision-making, Decision-making Process, Group Decision-making, Creativity Problem-solving.</p>
<p><b>Week 6:</b> Management by Objectives and Styles of Management : Core Concepts of MBO, Characteristics of Management by Objectives, Process of MBO, Defining the Goal, Action Plan, Final Review, Benefits of Management by Objectives, Limitations of Management by Objectives, Styles of Management, American Style of Management, Japanese Style of Management, Indian Style of Management</p>
<p><b>Week 7:</b> Organizing and Directing: Introduction, Organizational Design, Hierarchical Systems , Organization Structure, Types of Organization Structure, Formal and Informal Organization, Factors Determining Span of Management, Centralization and Decentralization, Span of control, Understanding authority and responsibility, Principles of Delegation, Authority, Developing a culture of Innovation and performance.</p>
<p><b>Week 8:</b> Staffing and Coordination: Introduction, Human Resource Management, Recent Trends in HRM, Technology in HRM, Economic Challenges, Workforce Diversity, Concept of Coordination, Need for Coordination, Importance of Coordination, Principles of Coordination, Coordination Process, Types of Coordination, Issues and Systems Approach to Coordination, Techniques of Coordination.</p>
<p><b>Week 9:</b></p>



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Career Development Strategy: Introduction, Concept and Elements of Career, Overview of Career Development, Significance and Advantages of Career Development, Objectives of Career Development, Types of Career Development Programmes, Different Stages or Cycles of Career Development Process, Career Anchors, Steps in the Career Planning Process.

**Week 10:**

Leadership styles of Managers: Leadership Concept, Nature, Importance, Attributes of a leader, Role of a leader in demonstrating awareness of legal, personnel, and strategic issues relating to globalization, culture and gender diversity in an organization, Role of leader in conflict resolution and negotiations

**Week 11:**

Organizational Communication: Communication in Organizations: Introduction, Importance of Communication in the Workplace; Understanding Communication Process, Barriers to Communication, Use of tone, language and styles in Communication, Role of Perception in influencing communication, Role of culture in communication

**Week 12:**

Change management: Concept of change, change as a natural process, Importance and Causes of change – social, economic, technological, organizational, Developing a climate for learning, Concept of learning organizations Challenges of Contemporary Business: Role of Ethics, Corporate social responsibility, and environmental issues

**Textbooks/ Reference Books:**

1. Stephen P. Robbins, David A. Decenzo, 2016. Fundamentals of Management, Pearson Education, 9<sup>th</sup> Edition
2. Harold Koontz, O'Donnell and Heinz Wehrich, 2012. Essentials of Management. New Delhi, 9<sup>th</sup> edition, Tata McGraw Hill
3. Management Fundamentals: Concepts, Applications, and Skill Development, 6<sup>th</sup> edition, Sage, 2014
4. Richard L. Daft, Principles Of Management, Cengage Learning, 2009
5. Robbins, Management, 9<sup>th</sup> edition Pearson Education, 2008



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**Self-Learning Course-1: Financial Accounting**

23EE4801D	HSSM	Financial Accounting	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: NA	CA1 :10 Marks CA2 :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Course Contents:**

<p><b>Week 1: A primer on business organizations and need for accounting</b>            Introduction to Financial Accounting, Definition of accounting, Course contents, Preparation of financial statements: Accounting cycle, Decision making using financial statements, Accounting: An art or a science?, Environment of financial reporting, Company form of business, 1What is a company?, 2Types of companies, Private company vs Public company, Visuals test to identify public companies, Accounting as an information system, Business and information requirement, Stakeholders of a business, Information: Tip of accounting ice-berg, Key accounting terms: Assets, Liabilities, Income, Expenses, Four key terms in accounting, Sources of funds, Use of funds, The sources vs The uses , Types of Assets, Types of Liabilities, Types of Incomes, Types of Expenses, Tutorial: Key accounting terms: Assets, Liabilities, Income, Expenses, Identifying the category and sub category of various accounting terms.</p>
<p><b>Week 2: Accounting equation, GAAP Principle and Fundamentals of double entry system</b>            Accounting equation, What is the accounting equation?, Working of accounting equation, Example: accounting equation, Summary: accounting equation, Walkthrough of Balance Sheet I, Walkthrough of Balance Sheet II, Walkthrough of Balance Sheet III, Walkthrough of Income Statement , Generally Accepted Accounting Principles I, Business Entity Concept, Money Measurement Concept, Going Concern Concept, Accounting Period Concept, Cost Concept, Generally Accepted Accounting Principles II, Conservatism Concept, Accrual Concept, Matching Concept, Full Disclosure Concept, Materiality, Recap and way forward, Types of accounts, What is an account?, What are types of accounts?, Tutorial - Types of accounts.</p>
<p><b>Week 3:</b>            Planning: Types of Plans, Planning Process, Introduction to Strategic Management, Types of Strategies, Understanding environment of business: Environmental appraisal – Industry Analysis - Porter’s Model of competitive advantage, analysis of organizational resources and capabilities</p>
<p><b>Week 4:</b>            Forecasting and Premising : Introduction to Forecasting, Essential Components in Business Forecasting, Determinants of Business Forecasts, Benefits of Forecasting, Techniques of Forecasting, Limitations of Forecasting</p>
<p><b>Week 5:</b>            Decision-making: Introduction, Components of Decision-making, Decision-making Process, Group Decision-making, Creativity Problem-solving.</p>
<p><b>Week 6:</b>            Management by Objectives and Styles of Management : Core Concepts of MBO, Characteristics of Management by Objectives, Process of MBO, Defining the Goal, Action Plan, Final Review, Benefits of Management by Objectives, Limitations of Management by Objectives, Styles of Management, American Style of Management, Japanese Style of Management, Indian Style of Management</p>



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<p><b>Week 7:</b> Organizing and Directing: Introduction, Organizational Design, Hierarchical Systems , Organization Structure, Types of Organization Structure, Formal and Informal Organization, Factors Determining Span of Management, Centralization and Decentralization, Span of control, Understanding authority and responsibility, Principles of Delegation, Authority, Developing a culture of Innovation and performance.</p>
<p><b>Week 8:</b> Staffing and Coordination: Introduction, Human Resource Management, Recent Trends in HRM, Technology in HRM, Economic Challenges, Workforce Diversity, Concept of Coordination, Need for Coordination, Importance of Coordination, Principles of Coordination, Coordination Process, Types of Coordination, Issues and Systems Approach to Coordination, Techniques of Coordination.</p>
<p><b>Week 9:</b> Career Development Strategy: Introduction, Concept and Elements of Career, Overview of Career Development, Significance and Advantages of Career Development, Objectives of Career Development, Types of Career Development Programmes, Different Stages or Cycles of Career Development Process, Career Anchors, Steps in the Career Planning Process.</p>
<p><b>Week 10:</b> Leadership styles of Managers: Leadership Concept, Nature, Importance, Attributes of a leader, Role of a leader in demonstrating awareness of legal, personnel, and strategic issues relating to globalization, culture and gender diversity in an organization, Role of leader in conflict resolution and negotiations</p>
<p><b>Week 11:</b> Organizational Communication: Communication in Organizations: Introduction, Importance of Communication in the Workplace; Understanding Communication Process, Barriers to Communication, Use of tone, language and styles in Communication, Role of Perception in influencing communication, Role of culture in communication</p>
<p><b>Week 12:</b> Change management: Concept of change, change as a natural process, Importance and Causes of change – social, economic, technological, organizational, Developing a climate for learning, Concept of learning organizations Challenges of Contemporary Business: Role of Ethics, Corporate social responsibility, and environmental issues</p>
<p><b>Textbooks/Reference Books:</b></p> <ol style="list-style-type: none"><li>1. Stephen P. Robbins, David A. Decenzo, 2016. Fundamentals of Management, Pearson Education, 9<sup>th</sup> Edition</li><li>2. Harold Koontz, O'Donnell and Heinz Weihrich, 2012. Essentials of Management. New Delhi, 9<sup>th</sup> edition, Tata McGraw Hill</li><li>3. Management Fundamentals: Concepts, Applications, and Skill Development, 6<sup>th</sup> edition, Sage. 2014</li><li>4. Richard L. Daft, Principles of Management, Cengage Learning, 2009.</li><li>5. Robbins, Management, 9<sup>th</sup> Edition Pearson Education, 2008.</li></ol>



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### Self-Learning Course-2: Introduction to Embedded System Design

23EE4802A	PEC	Introduction to Embedded System Design	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: NA	CA1 :10 Marks CA2 :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

#### Course Contents:

<p><b>Week 1:</b> Introduction to Embedded Systems and Computer Systems Terminology. Modular approach to Embedded System Design using Six-Box model: Input devices, output devices, embedded computer, communication block, host and storage elements and power supply.</p>
<p><b>Week 2:</b> Microcontroller Based Embedded System Design. Salient Features of Modern Microcontrollers. Elements of Microcontroller Ecosystem and their significance.</p>
<p><b>Week 3:</b> Design of Power Supply for Embedded Systems. Linear Regulator Topologies. Switching Power Supply Topologies. Power Supply Design Considerations for Embedded Systems.</p>
<p><b>Week 4:</b> Introduction to MSP430 Microcontroller. MSP430 CPU Architecture. Programming Methods for MSP430. Introduction to Lunchbox Platform.</p>
<p><b>Week 5:</b> Fundamentals of Physical Interfacing. Connecting Input Devices: Switches, Keyboard and Output devices: LEDs, Seven Segment Displays (SSD). Assignment: MCQ/MSQ</p>
<p><b>Week 6:</b> Advanced Physical Interfacing: Driving load - high side, low side and H-bridge. Multiplexing displays including Charlieplexing. Shaft encoder.</p>
<p><b>Week 7:</b> Programming the MSP430. Basics of version control system - Git. Installing and using Code Composer Studio (CCS). Introduction to Embedded C. Interfacing LEDs and Switches with MSP430 using Digital Input and Output.</p>
<p><b>Week 8:</b> MSP430 Clock and Reset System. MSP430 Clock sources and distribution. Types of Reset sources. Handling Interrupts in MSP430. Writing efficient Interrupt Service Routine (ISR).</p>
<p><b>Week 9:</b> Interfacing Seven Segment Displays and Liquid Crystal Displays with MSP430. Low Power Modes in MSP430. Introduction to MSP430 Timer Module and its Modes of Operation.</p>
<p><b>Week 10:</b> Generating Pulse Width Modulation (PWM) using Timer Capture Mode. ADC operation in MSP430. Interfacing analog inputs. Generating random numbers using LFSR and other methods. Adding DAC to MSP430. Custom Waveform generation using MSP430.</p>
<p><b>Week 11:</b> Timer Capture Modes. Measuring frequency and time period of external signals and events. Serial Communication Protocols: UART, SPI, I2C. Interfacing Universal Serial Communication Interface (USCI) Module of the MSP430 for UART Communication. Advanced Coding Exercises</p>



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based on Interrupt driven Programming. Building an Electronics Project.

**Week 12:**

Circuit Prototyping techniques. Designing Single Purpose Computers using Finite State Machine with Datapath (FSMD) approach. MSP430 Based Project Design and Implementation. Recap of Course Coverage.

**Textbooks/Reference Books:**

1. Designing Embedded Hardware, John Catsoulis, 2<sup>nd</sup> edition, Shroff Publishers and Distributors.
2. Embedded System Design: A Unified Hardware / Software Introduction, Tony Givargis and Frank Vahid, Wiley.
3. MSP430 Microcontroller Basics, John H. Davies, Elsevier.
4. Programming Embedded Systems in C and C++, Micheal Barr, Shroff Publishers and Distributors.



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**Self-Learning Course-2: Cloud Computing**

23EE4802B	PEC	Cloud Computing	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: NA	CA1 :10 Marks CA2 :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Course Contents:**

<b>Week 1:</b> Introduction to Cloud Computing
<b>Week 2:</b> Cloud Computing Architecture.
<b>Week 3:</b> Service Management in Cloud Computing.
<b>Week 4:</b> Data Management in Cloud Computing.
<b>Week 5:</b> Resource Management in Cloud
<b>Week 6:</b> Cloud Security
<b>Week 7:</b> Open Source and Commercial Clouds, Cloud Simulator.
<b>Week 8:</b> Research trend in Cloud Computing, Fog Computing
<b>Week 9:</b> VM Resource Allocation, Management and Monitoring
<b>Week 10:</b> Cloud-Fog-Edge enabled Analytics
<b>Week 11:</b> Serverless Computing and FaaS Model
<b>Week 12:</b> Case Studies and Recent Advancements.
<b>Textbooks/Reference Books:</b>  1. Cloud Computing: Principles and Paradigms, Editors: Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Wiley,2011 2. Enterprise Cloud Computing - Technology, Architecture, Applications, Gautam Shroff, Cambridge University Press, 2010 3. Cloud Computing Bible, Barrie Sosinsky, Wiley-India, 2010 4. Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Ronald L. Krutz, Russell Dean Vines, Wiley- India,2010



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**Self-Learning Course-2: Smart Grid: Basics to Advanced Technologies**

23EE4802C	PEC	Smart Grid: Basics to Advanced Technologies	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: NA	CA1 :10 Marks CA2 :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Course Contents:**

<p><b>Week 1:</b> Introduction to Smart Grid-I., Introduction to Smart Grid-II., Architecture of Smart Grid system, Standards for Smart Grid system, Elements and Technologies of Smart Grid System-I</p>
<p><b>Week 2:</b> Elements and Technologies of Smart Grid System-II, Distributed Generation Resources-I, Distributed Generation Resources-II, Distributed Generation Resources-III, Distributed Generation Resources-I</p>
<p><b>Week 3:</b> Introduction to energy storage devices Different types of energy storage technologies, Analytical modelling of energy storage devices, Optimal sizing and siting of storages, Battery management system (BMS)</p>
<p><b>Week 4:</b> Wide area Monitoring Systems-I, Wide area Monitoring Systems-II, Phasor Estimation-I, Phasor Estimation-II, Digital Relays for Smart Grid Protection.</p>
<p><b>Week 5:</b> Islanding Detection Techniques–I, Islanding Detection Techniques –II, Islanding Detection Techniques –III, Smart Grid Protection-I, Smart Grid Protection-II</p>
<p><b>Week 6:</b> Smart Grid Protection-III, Smart Grid Protection-IV, Modelling of storage devices, Modelling of DC smart grid components, Operation and control of AC Microgrid-I</p>
<p><b>Week 7:</b> Operation and control of AC Microgrid –II, Operation and control of DC Microgrid –I, Operation and control of DC Microgrid –II, Operation and control of AC-DC hybrid Microgrid –I, Operation and control of AC-DC hybrid Microgrid -II</p>
<p><b>Week 8:</b> Phasor measurement unit placement, Cyber security and resiliency, Virtual inertia and ancillary support, Demand side management of smart grid, Demand Response Analysis of smart grid</p>
<p><b>Week 9:</b> Demonstration of solar power generation, Demonstration of wind power generation, Demonstration of Battery Management System, Demonstration of EV charging system, Hierarchical control techniques in hybrid ac-dc microgrid</p>
<p><b>Week 10:</b> Simulation and case study of AC Microgrid, Simulation and case study of DC Microgrid, Simulation and case study of AC-DC Hybrid microgrid, Demonstration of parallel inverter operation in AC microgrid, Harmonic effects and its mitigation techniques.</p>
<p><b>Week 11:</b> Energy management, Design of Smart Grid and Practical Smart Grid Case Study-I, Design of Smart Grid and Practical Smart Grid Case Study-II, System Analysis of AC/DC Smart Grid,</p>



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Demonstration of grid-connected DC microgrid.

**Week 12:**

Demonstration of energy management in microgrid, Demonstration of PHIL experimentation for symmetric and asymmetric fault analysis of grid-connected DFIG wind turbine, Demonstration of ancillary support from virtual synchronous generator, Demonstration on peak energy management using energy storage system, Conclusions.

**Textbooks/ Reference Books:**

1. Smart power grids by A Keyhani, M Marwali.
2. Computer Relaying for Power Systems by ArunPhadke
3. Microgrids Architecture and control by Nikos Hatziargyriou
4. Renewable Energy Systems by Fang Lin Luo, Hong Ye
5. Voltage-sourced converters in power systems\_ modeling, control, and applications by Amirnaser Yazdani, Reza Iravani"



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**Self-Learning Course-2: Operations and Planning of Power Distribution Systems**

23EE4802D	PEC	Operations and Planning of Power Distribution Systems	3-0-0	3 Credits
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Teaching Scheme	Evaluation Scheme
Lecture: NA	CA1 :10 Marks CA2 :10 Marks Mid Semester Exam: 30 Marks End Semester Exam: 50 Marks

**Course Contents:**

<b>Week 1:</b> Introduction, overview, and Load modelling
<b>Week 2:</b> Load modelling
<b>Week 3:</b> Basic features of distribution systems
<b>Week 4:</b> Basic features of distribution systems.
<b>Week 5:</b> Reliability and Power quality assessment of distribution systems
<b>Week 6:</b> Reliability and Power quality assessment of distribution systems
<b>Week 7:</b> Distribution system load flow approach
<b>Week 8:</b> Reactive power compensation in distribution systems
<b>Week 9:</b> Distribution system planning and reconfiguration: Different approaches
<b>Week 10:</b> Distribution system planning and reconfiguration: Different approaches.
<b>Week 11:</b> Active distribution networks with the integration of Distributed Generation (DG)
<b>Week 12:</b> Distribution system automation and smart grid
<b>Textbooks/Reference Books:</b> 1. T. Gonen. Electric Power Distribution System Engineering; CRC Press, 3 <sup>rd</sup> Edition, 2014. 2. H. Lee. Willis. Power Distribution Planning Reference Book; CRC press; 2 <sup>nd</sup> Edition, Revised and Expanded, 2004. 3. S. Pabla, Electric Power Distribution; Tata Mcgraw-Hill Publishing Company Ltd., 5 <sup>th</sup> Edition, 2007. 4. Math Bollen and Fainan Hassan, Integration of Distributed Generation in the Power System; IEEE Press, 2011. 5. R. Billington and R. Allan, Reliability Evaluation of Power Systems; Springer, Berlin, 2 <sup>nd</sup> Edition, 1996.



*Shri Shamrao Patil (Yadavkar) Educational and Charitable Trust's*  
**Sharad Institute of Technology College of Engineering**  
**An Autonomous Institute**

Yadav (Ichalkaranji), Dist: Kolhapur, Maharashtra-416121

### Internship

23EE4803	PROJ	Internship	0-0-20	10 Credits
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Teaching Scheme	Evaluation Scheme
Practical: 20 hours/week	CA-I: 50 Marks CA-II: 50 Marks End Semester Exam: 100 Marks

**Course Outcomes:** At the end of the course, students will be able to:

CO1	Apply foundational engineering knowledge to effectively address real-world industrial challenges during the internship.
CO2	Demonstrate heightened interpersonal communication skills by interpreting and expressing ideas effectively within various professional environments.
CO3	Apply a comprehensive understanding of industry activities and functions, showcasing the ability to navigate and contribute effectively in professional engineering settings.
CO4	Analyze and synthesize experiences, observations, and learned concepts from the internship to compose technically proficient reports for effective communication.
CO5	Apply professionalism, punctuality, and responsible task completion as manifestations of a strong work ethic within the internship.
CO6	Synthesize initiative, curiosity, and active engagement, creating a mindset conducive to meaningful contributions to assigned tasks during the internship period.

#### **Description:**

An essential step in bridging the knowledge gap between academic study and practical application for engineering students is the internship program. Minimum eighteen-week internship program begins at the end of the seventh semester and allows students to interact with industries, associations for professionals, or research facilities. Strong communication skills and a basic comprehension of technical topics are essential qualities. The course outcomes place a strong emphasis on developing interpersonal communication skills, confirming technical knowledge in real-world situations, comprehending industry processes in depth, and writing thorough technical reports. It is encouraged of students to be on time, act professionally, and take initiative in their internships.

Guidelines emphasize the need of communication and call on students to promptly and politely discuss any problems they may have with coordinators and supervisors. Additionally stressed are initiative, enthusiasm, and timely execution of duties assigned. After the internship, students must put together a thorough report that is an invaluable tool. This report is evaluated according to standards including uniqueness, sufficiency, structure, and real-world application of principles learnt. In addition, a panel of experts evaluates the quality, efficiency, and organization of students' content delivery when assessing their presenting abilities.

A comprehensive assessment of the students' performance is provided by the overall evaluation, which also includes departmental reports and attendance records. The internship program's all-encompassing strategy attempts to promote engineering students' overall growth as they enter the workforce by instilling practical skills, industry understanding, and good communication.

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